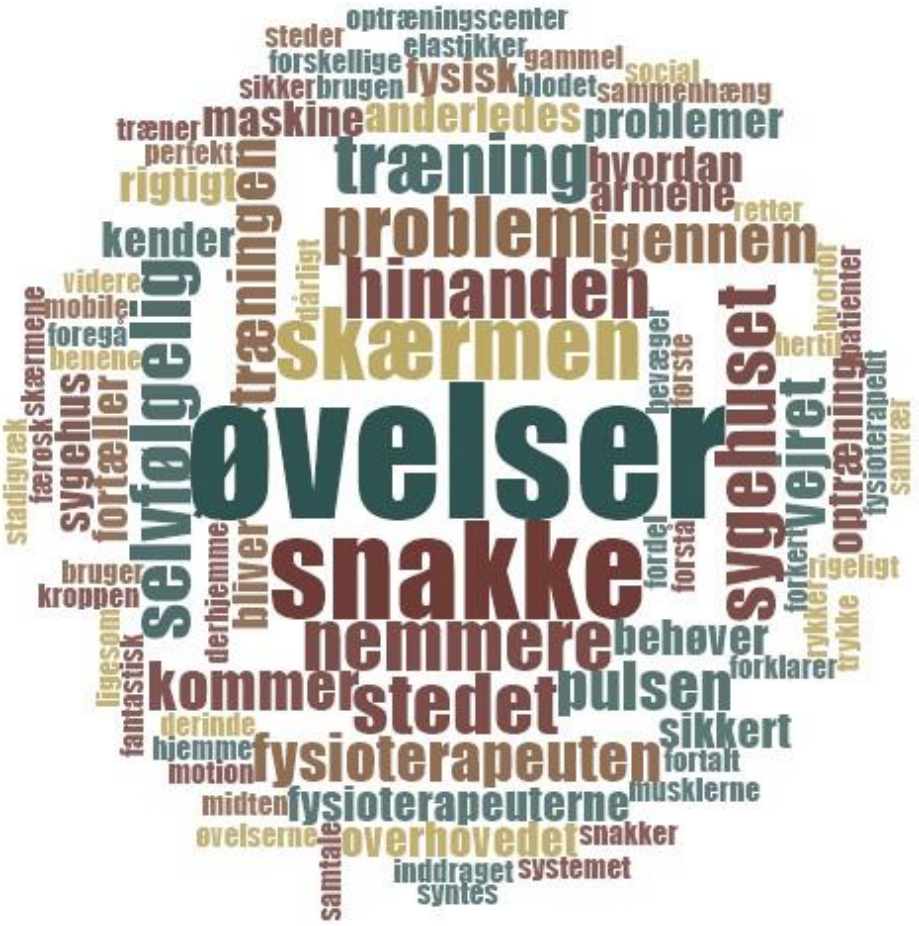
AALBORG UNIVERSITY

Master's Thesis

Implementation of a Telerehabilitation Device for Post-Coronary Artery Bypass Graft Patients in a Rehabilitation Program on The Faroe Islands: Exploring Opportunities and Barriers



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Title: Implementation of a Telerehabilitation Device for Post-Coronary Artery Bypass Graft Patients in a Rehabilitation Program on The Faroe Islands: Exploring Opportunities and Barriers

Institution: Aalborg University

Education: Clinical Science and Technology

Semester: 4th Semester

Semester theme: Master's thesis

Project period: February 1, 2024 – May 31, 2024

ECTS: 30

Supervisor: Pernille Heyckendorff Secher

Project group: 10510

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Number of pages: 62

Number of appendices: 10

Reference system: Vancouver

Abstract

Introduction: Cardiovascular disease, affecting over 607 million worldwide, is a leading cause of death, with coronary artery disease representing a significant portion. Coronary artery bypass grafting is the most common surgical intervention for severe coronary artery disease. Inadequate rehabilitation increases the risk of health decline and readmission, amplifying healthcare costs. Challenges maintaining adherence to center-based cardiac rehabilitation long-term prompts alternative exploration. Telerehabilitation, often home-based, emerges as a promising solution. Despite technological progress, global implementation of telerehabilitation devices for coronary artery bypass graft patients in rehabilitation programs remains unexplored.

Method: Employing a qualitative case study design, factors influencing the b-near touch screen solution implementation at Suðuroy Hospital (Faroe Islands) were explored. Data collection involved document materials, direct non-participant observations and semi-structured interviews with 7 participants. Analysis with NVivo followed principles by Kvale and Brinkmann and the Normalization Process Theory.

Findings: The case study revealed both opportunities and barriers. At Suðuroy Hospital, the b-near touch screen solution proves advantageous by facilitating training as well as communication between healthcare providers and patients, enabling patients to effortlessly manage the technology, and eliminating the need for transportation to the hospital. However, barriers such as lack of social interaction and potential difficulties in comprehending training audio were also identified.

Conclusion: The telerehabilitation device implementation for Coronary artery bypass graft patients reveals unique factors. The Faroe Islands' European Union non-membership enables the use of non-medical devices like the b-near system, improving patient accessibility. The study highlights opportunities and barriers, emphasizing the need to integrate findings into Suðuroy Hospital's implementation strategy. Overcoming the barriers is essential for successful b-near system implementation, enhancing coronary artery bypass graft patient care.

Keywords: coronary artery bypass grafting, cardiac rehabilitation, implementation, technology, telerehabilitation.

Preface

This project was initiated and developed to fulfill the master's thesis requirement within the master's program in Clinical Science & Technology at Aalborg University. The idea for the project stems from previous work experience addressing challenges with adherence to center-based cardiac rehabilitation on the Faroe Islands. The project group comprises Bertil Christian Pløen Sivertsson, holding a bachelor's degree in physiotherapy, and Alex Voss Gartner, holding a bachelor's degree in occupational therapy. The project commenced in February 2024 and concluded in May 2024.

A collaboration agreement was established between Suðuroy Hospital and the project group to facilitate data collection from both Denmark and the Faroe Islands. Additionally, an agreement was made with b-near a/s for them to donate 8 b-near touch screen solutions, which were utilized in the project for coronary artery bypass graft patients in a rehabilitation program on the Faroe Islands. This initiative aimed to enhance our understanding of implementing telerehabilitation devices for this specific patient group.

This project report is intended for individuals involved in the field of coronary artery bypass grafting and telerehabilitation, as well as healthcare professionals working with coronary artery bypass graft patients and cardiac rehabilitation, who may find its insights valuable.

We extend our sincere gratitude to our supervisor, Associate Professor Pernille Heyckendorff Secher, for her expert guidance and continuous support throughout the project phases. Furthermore, we express our appreciation to the entire staff at Suðuroy Hospital and b-near a/s, as well as their collaboration partners, for their professional feedback and collaborative efforts.

Additionally, we want to express our thanks to the grant providers who made this research project possible: Familien Hansens Fond, Det Obelske Familiefond, and Aalborg University. We are deeply grateful to these organizations for their invaluable contributions, enabling the funding of our research activities in the Faroe Islands.

Transcriptions of interviews and notes from various phases are not included in the appendices but can be requested from the project group via the email address hst-24-kvt-10-10510@student.aau.dk. The front page's word cloud, created with NVivo, showcases the most common interview words.

Aalborg University, May 2024.

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1 Problem analysis

This chapter will provide a comprehensive problem analysis for the project, covering a range of crucial aspects. It will begin with an overview of the epidemiology of cardiovascular disease (CVD), followed by an examination of its economic impact in both the US and Europe. Detailed discussions on treatment methods for coronary artery disease (CAD), specifically focusing on coronary artery bypass grafting (CABG), will follow. Subsequently, the importance of cardiac rehabilitation (CR) for CABG patients will be explored. Additionally, alternatives for center-based cardiac rehabilitation (CBCR) will be introduced, with a particular emphasis on video-based telerehabilitation communication technology. This aims to bridge a significant research gap identified in current literature, ensuring equitable access to advanced CR services and optimizing patient outcomes. Finally, a case will be presented to serve as a rationale for formulating the project's problem statement and underlying research questions, providing a contextual overview of a case study, along with an exploration of the b-near touch screen solution (b-near).

1.1 Cardiovascular Disease

CVD is a leading global cause of death [1]. This disease affects the cardiovascular system, which consists of the heart and blood vessels [2]. A variety of issues may occur in this system, including endocarditis, rheumatic heart disease, and abnormalities in the conduction system [3]. Typically, these issues become even more prevalent with advancing age [4]. CVD, commonly known as heart disease, encompasses four main conditions: cerebrovascular disease, peripheral artery disease (PAD), aortic atherosclerosis and CAD, also known as coronary heart disease [3]. Cerebrovascular disease involves strokes, including transient ischemic attacks. PAD primarily affects the limbs and can lead to claudication. Aortic atherosclerosis is linked to thoracic and abdominal aneurysms [3]. CAD is characterized by a gradual accumulation of fatty and calcium deposits (plaque) within the arteries supplying blood to the heart. This diminishes blood flow to the heart, resulting in chest pain known as angina, or in cases of complete artery blockage, triggering a heart attack or heart failure. CVDs are pervasive, exhibit low survival rates, and are on the rise worldwide. The prevalence of total CVD cases surged from 271 million in 1990 [5] to 607.64 million in 2020 [6]. During the same period, CVD-related deaths steadily increased from 12.1 million in 1990 [5] to 19.05 million in 2020 [6]. CAD constitutes between one-third and one-half of all CVD cases, translating to an estimated 200 million cases globally [3, 7, 8].

1.2 The Economic Impact of Cardiovascular Disease in the US and Europe

In a 2017 study conducted by the American Heart Association (AHA), it was reported that CVD imposed a financial burden of $555 billion in the United States in 2015. Of this total, $318 billion was attributed to direct medical costs, while an additional $237 billion accounted for indirect costs [9]. Similarly, CVD presents itself as a notable financial burden in Europe as numbers from a study from 2023 by Luengo-Fernandez et al. estimates a total cost of €282 billion in Europe in 2021. Delving into the specifics of this economic burden reveals a nuanced distribution across various sectors. Healthcare expenses emerges as a significant contributor, constituting 46% of the total cost of CVD. Social care and informal care accounted for 9% and 28%, respectively, emphasizing the multifaceted nature of the economic impact. Additionally, 17% of the total cost was attributed to productivity losses, highlighting the broader societal repercussions beyond immediate healthcare expenses. The total estimated cost of CAD in the European Union (EU) amounted to €77 billion, constituting more than one-quarter of the overall financial burden of CVD. On average, this translated to €173 per EU citizen. However, when considering price variations across member states, the cost ranged from €100 in Luxembourg to €325 in Lithuania [10].

1.3 Treatment of Coronary Artery Disease

Essentially, there are three main therapeutic principles for managing CAD: Conservative therapy, percutaneous coronary intervention (PCI) and CABG, commonly known as heart bypass surgery [11].

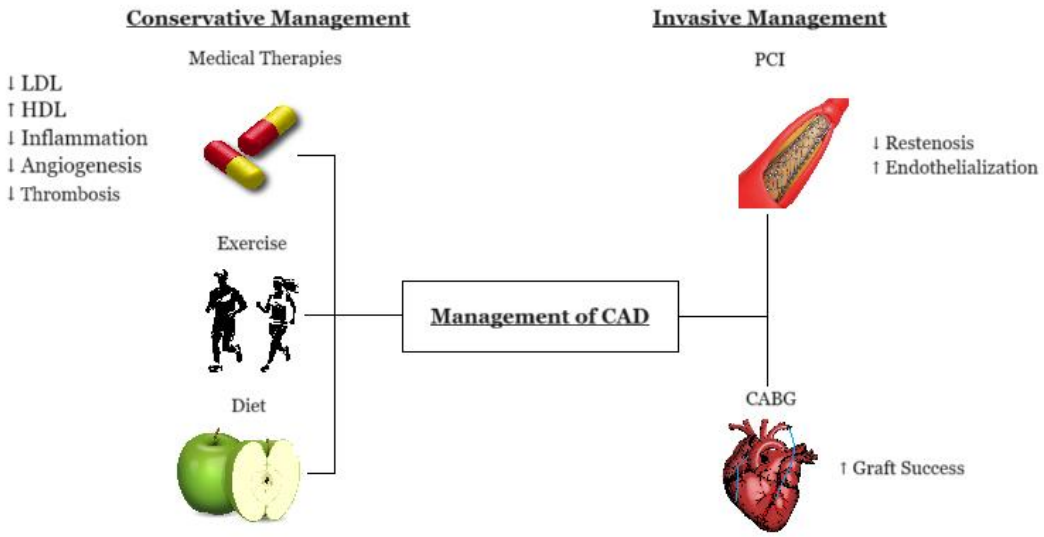

Figure 1 The three main therapeutic principles for managing CAD

1.3.1 Conservative Therapy

Conservative therapy aims to halt the progression of atherosclerosis, alleviate symptoms, and prevent atherothrombotic events [12]. This approach involves lifestyle modifications, such as exercise and diet, along with medical therapy [13].

The medical treatment, which is the cornerstone of CAD management, typically includes anti-ischemic drugs like beta-blockers or calcium-channel inhibitors, as well as antiplatelet therapy (e.g., aspirin or clopidogrel), statins, lipid-lowering agents, and renin-angiotensin-aldosterone system (RAAS) inhibitors, tailored to each patient [11]. Medical therapy primarily focuses on symptom control and improving quality of life, with a significant proportion of patients experiencing relief without the need for invasive treatments [14]. However, some patients may require additional interventions due to persistent symptoms, as observed in the International Study of Comparative Health Effectiveness with Medical and Invasive Approaches (ISCHEMIA) trial where 21% of patients in the conservative treatment group received invasive procedures during the study [15].

The benefits of medical treatment extend to patients undergoing PCI or CABG, where medical therapy serves as a vital complement to these procedures. While both PCI and CABG have the potential to alleviate symptoms and potentially enhance prognosis in patients with clinically significant CAD, their utilization should be based on evidence of benefit given their associated risks. Effective management of CAD patients necessitates close collaboration among surgeons, cardiologists, and primary care physicians to ensure comprehensive care and optimal outcomes [11].

Figure 2 Conservative Therapy: Medical therapy along with Exercise and diet

1.3.2 Percutaneous Coronary Intervention

PCI is a minimally invasive procedure aimed at alleviating the narrowing or blockage of coronary arteries to enhance blood flow to ischemic tissue. This procedure typically involves various techniques, with the most prevalent ones including balloon angioplasty to widen narrowed segments or the deployment of a stent to maintain artery patency [16]. The guidelines suggest tailoring PCI to suit the needs of patients with CAD, considering factors such as clinical status, severity of stenosis, and the diverse range of methods available to confirm ischemia [11]. Consistent evidence has affirmed the symptomatic therapeutic impact of PCI [13, 17]. Nonetheless, the prognostic advantages of PCI in chronic CAD remain a subject of ongoing debate [11]. PCI stands out as the optimal treatment for acute myocardial infarction due to its rapid application, leading to symptom alleviation and increased life expectancy [17].

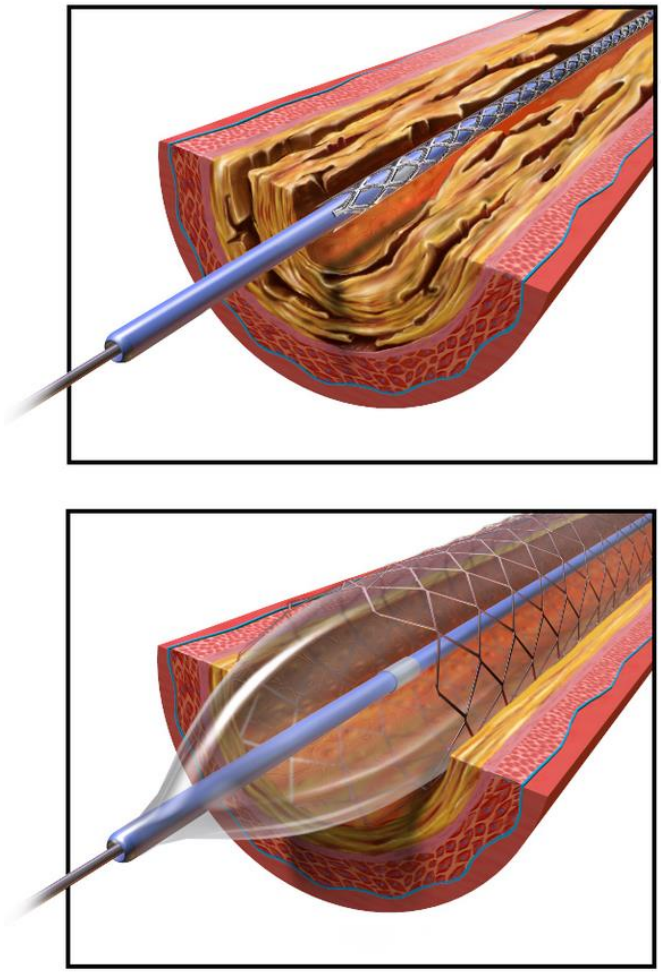

Figure 3 PCI Procedure [18]

1.3.3 Coronary Artery Bypass Grafting

CABG is a significant surgical procedure designed to bypass atheromatous blockages in coronary arteries using harvested venous or arterial conduits. The surgeon performs a median sternotomy to prepare for accessing the left internal mammary artery as a conduit. Meanwhile, a trained assistant removes the saphenous vein from one or both legs using open or video-assisted techniques. Once suitable conduits are obtained, the surgeon administers anticoagulation, usually heparin, in preparation for cardiopulmonary bypass (CPB). The patient's aorta and heart are centrally cannulated, and tubing is connected to the CPB circuit. After initiating CPB, the heart is stopped using high potassium cardioplegia, allowing the surgeon to attach the conduits to the coronary arteries beyond the blockages. Once the distal anastomoses are completed, the conduits are connected to newly created openings in the proximal aorta. Cardioplegia is then washed out, allowing the heart to resume contractions, while the surgeon checks the grafts for blood flow and competency and examines the anastomosis sites for bleeding. Following this, the chest is closed with sternal wires, and the patient is transferred to the intensive care unit for hemodynamic monitoring and extubation. This process restores blood flow to the ischemic myocardium, improving function, viability, and relieving anginal symptoms [19].

Despite being the most common surgical heart procedure worldwide, with over 600.000 annual surgeries [20], its prevalence has declined due to the increasing adoption of medical treatment and PCI [19]. However, the persistent rise in the overall number of CVD cases worldwide indicates a sustained demand for CABG procedures. CABG is performed on patients diagnosed with severe CAD [7]. Guidelines advocate for CABG as the primary therapy for anatomically complex CAD, which is considered virtually equivalent to PCI in patients with less complex anatomical presentations [17]. In cases of acute coronary syndrome, bypass surgery becomes a viable treatment alternative when primary PCI is not feasible or complications arise [17]. Furthermore, careful patient selection for CABG leads to greater survival benefits compared to those treated solely with medical therapy or PCI [21]. CABG is recommended when high-grade blockages are present in major coronary arteries or when PCI proves ineffective in clearing the blockages [19]. The 2011 American College of Cardiology Foundation (ACCF)/AHA Task Force guidelines offer Class 1 recommendations for such scenarios, including left main disease greater than 50%, three-vessel coronary artery disease of greater than 70% with or without proximal left anterior descending artery (LAD) involvement, two-vessel

disease involving LAD plus one other major artery, and one or more significant stenosis greater than 70% in a patient with significant anginal symptoms despite maximal medical therapy [22].

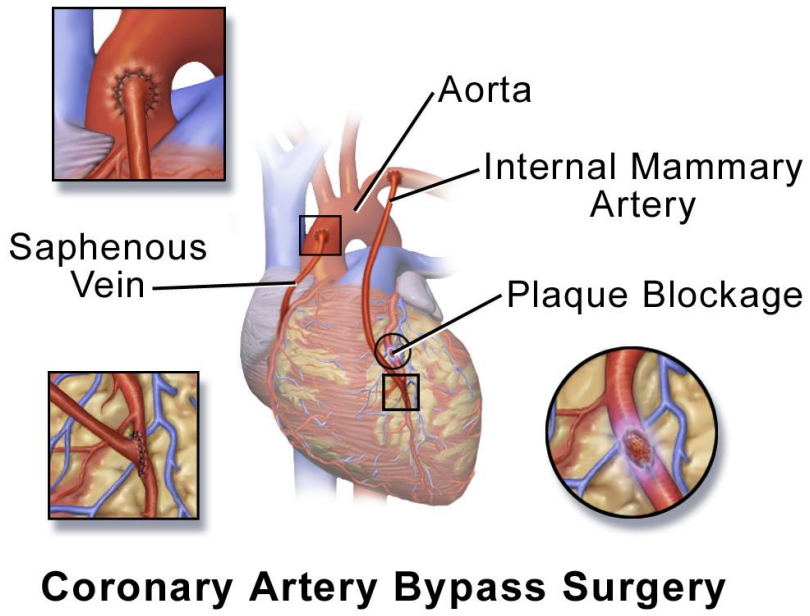

Figure 4 CABG Procedure [23]

CABG typically requires a hospital stay of nearly a week, and upon discharge, patients generally require a convalescence period lasting 2 to 6 weeks. This period is essential for recovery from the procedure and resuming normal daily activities, including potential return to work. A considerable number of patients must address persistent issues such as heart failure, anemia, atrial fibrillation, pulmonary abnormalities, and lingering pain associated with thoracotomy and saphenectomy. During later follow-up, patients may encounter recurrent angina or acute coronary syndrome resulting from the progression of CAD in the native coronary circulation or due to bypass failure, especially with venous grafts, which tend to develop stenosis after several years [24]. Following the CABG, patients are prescribed a complex medication regimen and advised to embrace a healthy lifestyle, which includes quitting smoking, maintaining a balanced diet, engaging in moderate exercise, and managing psychological stress. While patients typically willingly adhere to these behaviors shortly after CABG, maintaining adherence becomes more challenging in the long term [25–27].

1.4 Cardiac Rehabilitation

CR is a crucial aspect of care for patients with heart conditions [28] and consists of a comprehensive program that combines personalized and supervised exercise with education, both of which are crucial for patients following CABG. This program functions in two main ways: firstly, CR facilitates a

quicker and more effective recovery from heart surgery during the initial weeks after the procedure. This is especially significant for the typical CABG patient, who is often an elderly individual with multiple comorbidities and limitations. Secondly, CR equips patients with healthy habits, resources, and the necessary knowledge to effectively manage CAD over the long term [24]. The World Health Organization (WHO) has defined CR as ”the sum of activities required to influence favourably the underlying cause of the disease, as well as to provide the best possible physical, mental, and social conditions, so that the patients may, by their own efforts, preserve or resume when lost as normal a place as possible in the community” [29].

Considering the significance of patients achieving a complete and rapid physical recovery following surgery to enable a quick return to normal daily activities, including work, coupled with the importance of embracing a healthy lifestyle and adhering to a specific long-term medication regimen, CR stands out as a highly recommended choice for CABG patients [30, 31]. This recommendation is further underscored by the ACCF/AHA guidelines, which advocate for CR in all qualified patients after CABG [22].

CR timing is categorized into three phases [32]: In phase 1, the acute stage occurring within 7 days of onset, patients engage in gentle exercises aimed at early recovery and stabilization. Phase 2, known as the healing stage, spans from 1 week to 6 months after onset. During this phase, patients are enrolled in personalized training programs tailored to their individual needs. In phase 3, the healed stage occurring more than 6 months after onset, patients are encouraged to maintain independence and continue a healthy lifestyle [32–34].

The beneficial effects of CR after CABG are primarily demonstrated in phases 2 and 3 [35]. Nonetheless, findings from an inpatient database study conducted by Ohbe et al. suggest that initiating early rehabilitation within 3 days of CABG is safe. This approach has the potential to decrease in-hospital mortality, total hospital costs, length of stay in the intensive care unit, and overall hospital duration following CABG [36].

Similarly, a study by Shan et al. illustrates the benefits of early exercise rehabilitation in enhancing cardiopulmonary function, increasing exercise tolerance, and improving quality of life among CABG patients. The intervention group exhibited significantly shorter total hospitalization time compared to

the control group ($P < 0.05$), which received conventional treatment and routine care. Additionally, the intervention group showed lower hospitalization costs ($P < 0.05$) and a reduced overall incidence of pulmonary infection and hypoxemia ($P < 0.05$) [37]. Cardiac surgery rehabilitation, recognized for its positive impact on self-assessment, clinical parameters, and overall physical capacity, is associated with a reduction of more than 30% in cardiac mortality [38, 39]. Moreover, CR has demonstrated significant advantages in lowering readmission rates [40].

Despite international guidelines and the well-documented benefits of CR, participation rates in rehabilitation programs for this patient group remain persistently low [41].
Factors such as lower educational attainment, nonsurgical diagnoses, current smoking habits, and low to moderately reduced ejection fraction, as well as the geographical variable distance between a patient eligible for CR and the nearest program facility, are significant predictors of nonparticipation [41–43].

In general, only a small proportion of patients are admitted to such programs, with many being discharged without rehabilitation [42, 44, 45]. Without sufficient rehabilitation, patients face an increased risk of declining health and rehospitalization, contributing to high readmission rates within the first 30 days post-surgery, particularly in the first week after hospital discharge. These challenges not only impact patient well-being but also add to the financial burden on healthcare systems. Furthermore, postoperative complications such as cognitive impairment, memory loss, and limited daily activities further exacerbate the risks [46–48]. Consequently, there is a pressing need to address these challenges. With the advancements in telehealth, alternative technologies to traditional CBCR may offer a solution.

1.5 Telerehabilitation and Home-based Cardiac Rehabilitation

Telehealth and remote monitoring represent significant innovations that have the potential to improve the availability of CR treatments, particularly in regions with limited access to healthcare services [49]. Various telerehabilitation technologies, such as wearable wrist sensors [50], patient-centered web portals [51], smartphone applications [52], and real-time video-based technology [44, 53], have been utilized in home-based cardiac rehabilitation (HBCR) programs. Telerehabilitation encompasses the utilization of information and communication technology to deliver rehabilitation services remotely [54–56]. As a form of telehealth, it employs remote technology systems to administer

rehabilitation from a distance, serving as a substitute for traditional person-to-person interactions [57]. This approach is particularly beneficial when rehabilitation facilities are inaccessible due to patients' geographic locations, and it enables patients to bypass the need for travel time to access rehabilitation services [58]. These technological tools can contribute to the delivery of HBCR, providing opportunities to expand the reach of CR, enhance patient engagement, and facilitate communication between patients and healthcare providers (HPs) [59].

HBCR serves as an alternative to CBCR services conducted in medically supervised facilities, relying on remote coaching and indirect exercise supervision, often taking place entirely outside of the traditional center-based environment. In theory, HBCR has the potential to address several challenges encountered by CBCR programs, such as geographic, logistical, and other access-related barriers [60]. These programs aim to increase participation, especially for older individuals and those in rural areas facing challenges attending center-based facilities. HBCR, either alone or in combination with CBCR is proposed as an alternative, potentially yielding clinical outcomes comparable to traditional rehabilitation programs [61]. This approach not only enhances patient participation but also has the potential to positively impact various aspects of healthcare utilization [44]. While home-based exercise training is frequently advised by CBCR staff for patients on days when they do not attend the CBCR in person, exclusive HBCR programs, functioning as the sole intervention, are still in the early stages of development [61]. Nevertheless, according to the European guidelines on CVD prevention, home-based rehabilitation, with or without telemonitoring, shows potential for enhancing participation and facilitating behavioral changes [62].

1.6 Video-based Telerehabilitation Communication Technology

Video-based telerehabilitation communication technology is currently undergoing extensive scientific evaluation within HBCR programs, where various technologies are being incorporated. Notably, video-based communication technology for CR consultations between patients and HPs emerges as one of the most frequently utilized options.

A review conducted by Lear et al. has outlined the prevalent communication technologies integrated into various virtual CR programs, along with their respective pros and cons [59]. Video conferencing is lauded for its synchronous and immediate communication capabilities, fostering robust patient engagement, particularly through virtual face-to-face interactions. However, it comes with drawbacks

such as scheduling constraints, specific hardware/software requirements, limited data capture, and potential setup expenses. Smartphone applications are another option, offering benefits such as facilitating data transfer, portability, and affordability. Nonetheless, the small screen size may pose challenges for individuals with vision impairments, and effective use of these applications may require a certain level of digital literacy. Web-based applications excel in facilitating data transfer, providing accessibility from any location at any time, and supporting large visual displays at relatively low cost. However, similar to smartphone applications, users may require a certain level of digital literacy to utilize them effectively [59]. In a study conducted by Peng et al., a telehealth exercise training program utilized online webcam communication and supervision through QQ and WeChat software, which patients accessed through a smartphone. The program involved a multidisciplinary team including physiotherapists for exercise training, cardiac nurses for follow-up and self-care instruction, and psychiatric nurses for psychological guidance. Their findings demonstrated the successful development of a telehealth exercise training program specifically designed for patients with heart failure, with observed improvements in both quality of life and functional exercise capacity. They concluded that the utilization of such a telehealth exercise training program represents a practical and effective strategy for CR [63]. While all participants in the study reported no difficulties in using the QQ and WeChat software during the program, it is important to note that one of the inclusion criteria was the ability to use WeChat or QQ software via a smartphone. Therefore, this statement may not accurately reflect a real-life clinical setting due to this requirement. Similarly in a randomized controlled trial, Saitoh et al. assessed the feasibility of a remote CR support program (Remote-CR) among elderly patients with cardiac disease. A significant number of patients found Remote-CR to be an acceptable means of accessing a comprehensive CR program. However, despite the inclusion of patients with a certain level of digital literacy, feedback regarding usability or connectivity issues was received from some individuals. Therefore, enhancements to the user-friendly nature of the system and applications would be necessary to support sustained utilization for broader clinical implementation [64].

Despite the advantages of video-based communication technology use for CR, a gap in the existing research has been identified regarding the implementation of these technologies for CR of CABG patients. The lack of research on implementing video-based telerehabilitation for CABG patients could limit their access to innovative CR interventions, leading to suboptimal outcomes in recovery and quality of life. Additionally, delayed integration of these devices into standard CR protocols may

hinder the adoption of innovative technologies in CR. Addressing this research gap is crucial for ensuring equitable access to advanced CR services and optimizing patient outcomes. In the context of this project, 'implementation' refers to a pattern of organized, dynamic, and contingent interactions in which individuals and groups work with a complex intervention, such as telerehabilitation devices, within a specific context or health system, over time [65]. This definition highlights the dynamic and multifaceted aspects involved in implementing such technology into the context of CABG patient care.

1.7 Presentation of the Case

The case takes place in the Physiotherapy Department at Suðuroy Hospital in the Faroe Islands. For more information about the Faroe Islands, its health care system, and medical device regulation, see appendix A.

1.7.1 Suðuroy Hospital

Suðuroy Hospital, located in the city of Tvøroyri on Suðuroy, the most southern island of the Faroe Islands, serves the population of the island, which had 4,589 inhabitants as of February 2024 [66]. The hospital operates as a comprehensive medical facility, offering both surgical and medical services to ensure round-the-clock care for patients. With a dedicated team of 110 staff members [67], including two surgical superintendents and one medical superintendent, the hospital provides quality health care services to the community [68]. In 2023, the hospital served a total of 1,171 inpatients and 14,394 outpatients. The hospital offers 26 sleeping accommodations and hosts a laboratory in the medical center in Vágur. This laboratory is open twice a week for outpatient services such as blood tests, improving accessibility to diagnostic services for the local community. Additionally, resident duty is organized to cooperate with the general practitioner between 16:00 and 8:00, ensuring continuous coverage and care [68]. Overall, Suðuroy Hospital strives for a unified hospital operation at an international level, characterized by innovation. Collaboration among the three main hospitals—The National Hospital, Klaksvík Hospital, and Suðuroy Hospital—based on shared values ensures respect for patients and staff, while ongoing development supported by new technology is prioritized. Early diagnosis and treatment, coupled with an open and inclusive culture fostering closeness and service, contribute to resilience and innovation, leading to improvements in quality and increased efficiency in health care services [67].

1.7.1.1 Cardiology Department

Within the Cardiology Department at Suðuroy Hospital, comprehensive examinations are conducted for both admitted and outpatient cardiac patients. This includes the management of anticoagulation treatment (Marevan). The examinations encompass a range of diagnostic procedures such as echocardiography, exercise electrocardiography and Holter monitoring. Furthermore, nurses offer guidance to prevent atherosclerosis in patients diagnosed with coronary artery disease and aid in lifestyle adjustments for those with reduced pump function in the heart chambers [69]. Admitted patients can be referred to the Physiotherapy Department by a hospital doctor, where they receive physiotherapy and occupational therapy twice daily [70]. In 2023, a total of 525 cardiac patients were registered as having been in contact with the Cardiology Department.

1.7.1.2 Physiotherapy Department

The Physiotherapy Department at Suðuroy Hospital offers modern facilities, featuring spacious treatment rooms with ample lighting, a well-equipped exercise hall, and a hot water swimming pool. The department is staffed by a chief physiotherapist, three physiotherapists, two occupational therapists, and a healthcare assistant, ensuring comprehensive rehabilitation services [70]. In addition to in-hospital care, home visits are available, and assistance with obtaining assistive devices is provided if needed [71]**.** Upon discharge, patients have the option to continue their rehabilitation through outpatient sessions at the department, attending 2-3 times a week for three months [70]. In 2023, a total of 8,352 patients were registered as having contact with the Physiotherapy Department. However, it has not been possible to distinguish which of these patients were cardiac or CABG patients.

CABG patients who have undergone surgery at Rigshospitalet, as this procedure is not performed on the Faroe Islands [72], face challenges upon returning to Suðuroy Hospital. The Faroese archipelago's rugged terrain, comprising 18 islands [73], coupled with unpredictable rough weather conditions, exacerbates transportation challenges for patients accessing adequate rehabilitation services across the entire Faroe Islands. Demographically, the Faroe Islands are witnessing a significant aging trend. In 2024, 48.8% of the population is aged 40 or above, with a notable 70.5% surge in the number of individuals aged 67 or older since 1986 [66]. While the total fertility rate stands at 2.05 children per woman—higher than Denmark's [74]—the figure remains below the replacement threshold of 2.1

children per woman [75]. This demographic shift mirrors global trends, indicating an aging population and the associated healthcare implications. In light of these challenges and Suðuroy Hospital's commitment to advancing through technological innovations, integrating a telerehabilitation device into the CR program emerges as a logical step forward.

1.7.2 b-near Touch Screen Solution

The b-near system is a two-way video communication aid designed for the elderly and individuals with physical and cognitive impairments [76, 77]. It serves as an assistive device, fostering meaningful communication and closeness among individuals. Developed in close collaboration with professionals and caregivers, every feature of b-near is carefully designed to enhance connections and enrich the lives of users on both ends of the screen. Moreover, the solution boasts a locked interface, a button for SOS/safety calls, and prioritizes user-friendliness and intuitiveness, enabling video conferencing with just a single touch [78–80].

Figure 5 The b-near touch screen solution [81]

The screen solution comprises a Samsung A8 tablet, utilizing primarily its hardware alongside exclusive b-near software and an app administered via a smartphone by an administrator. The

administrator can configure the b-near screen to display what the screen user can manage. For example, this could include how many contacts can be seen at once. Family members and friends wishing to connect with the b-near screen can download a free app on their smartphones. From the app, they can receive or initiate calls by appearing visible on the user's screen [80, 82].

The screens are compatible with both Wi-Fi and mobile data. Notably, the user of the b-near screen does not have access to the underlying android system, apps, or functions on the device [82]. Additionally, the screen has recently been translated to Faroese [83]. In relation to the Medical Device Regulation (MDR) 2017/745 [84] and Medical Device Software (MDSW) [85], the b-near has not been registered as a medical device. However, it is registered with the Danish Authority of Social Services and Housing's AssistData as an assistive device for intercoms [81]. Personal data is processed and shared with Google, Twilio, and Hexnode. B-near have entered into data processing agreements with Google Ireland Ltd. (for hosting and backup), Twilio Ireland Limited (as a communication tool), and Hexnode (for mobile device management). All data is stored on encrypted servers in the EU/EEA, with servers located in Germany (Google and Hexnode) and Ireland (Twilio). The b-near handles data with utmost care and compliance with GDPR regulations. If needed b-near has IT support provided by the Danish-based company Makeable, which does not use subcontractors [82].

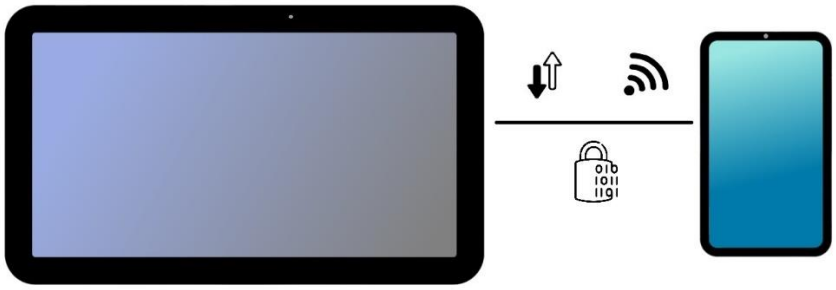

Figure 6 Two-way encrypted video communication between tablet and smart phone via either WIFI or mobile data

In their promotional materials, the company highlights the b-near as a tool capable of enhancing the quality of life and facilitating social interaction and communication for various groups of people, including the elderly, individuals with dementia, brain injuries, physical, mental, and cognitive challenges, those temporarily ill, and families with children [80]. In a recent unpublished qualitative

study by Blok [82], the use and impact of b-near technology were examined among elderly individuals affected by dementia, as well as those facing cognitive and physical challenges. The study also investigated the perspectives of their relatives and professionals. The study involved gathering qualitative data through interviews with current users, their relatives and professionals. Results revealed diverse usage patterns of the b-near, ranging from serving as an alternative phone to facilitating visual contact and sharing pictures and videos. Reported benefits included enhanced communication, feelings of security, and increased happiness for both users and their relatives. Furthermore, the screen was observed to save time, alleviate guilt, and strengthen relationships, even across distances. Importantly, the study demonstrated that involving relatives in patient care positively impacted patients' physical, psychological, and emotional well-being, highlighting the significance of user engagement in health care [82]. However, research on the utilization of the b-near is generally scarce, and to date, no studies have been conducted on its application for CABG patients in a rehabilitation program.

1.8 Summary

CVD is a leading global cause of death and encompasses various conditions affecting the heart and blood vessels. This includes CAD, which is characterized by plaque buildup in heart arteries, and is a major contributor to CVD cases globally. CVD imposes significant financial burdens in the US and Europe, with costs attributed to direct medical expenses, social care, and productivity losses. In Europe, CAD alone accounts for more than one-quarter of the overall financial burden of CVD. Three main therapeutic principles are employed for managing CAD: Conservative therapy, PCI, and CABG. CABG involves bypassing blockages in coronary arteries using harvested conduits. Despite declining prevalence due to medical treatment and PCI, it remains a crucial treatment for anatomically complex CAD, offering survival benefits over medical therapy or PCI in selected cases. CR, comprising exercise and education, plays a vital role in CABG care, facilitating recovery and long-term management of CAD. It is recommended for all qualified CABG patients to promote physical and psychological well-being. Despite this, participation rates for CBCR are persistently low due to factors such as the geographical variable distance between a patient eligible for CR and the nearest program facility. Without sufficient rehabilitation, patients face an increased risk of declining health and rehospitalization. These challenges not only impact patient well-being but also add to the financial burden on healthcare systems. Advancements in telehealth and remote monitoring have led

to the development of telerehabilitation programs, including HBCR. HBCR aims to overcome barriers to traditional CBCR, enhancing accessibility and participation. Video-based communication technology, despite its usability challenges, holds promise for facilitating remote CR consultations. However, research on its implementation for CABG patients is lacking, highlighting the need for further investigation and integration into standard CR protocols.

In this project, the b-near system, an innovative digital tool tailored for elderly patients unfamiliar with advanced smartphones and tablets, will be employed. The purpose is to explore the factors influencing the implementation of a telerehabilitation device as an assistive tool for CABG patients participating in a CR program. This exploration will be conducted through a case study at Suðuroy Hospital, Faroe Islands. While not specifically designed for this purpose, the system prioritizes user-friendliness and intuitiveness, suggesting its potential to address existing usability challenges among telerehabilitation devices. Moreover, the recent translation of the b-near into Faroese [83] enhances its applicability in regions facing language barriers. On the Faroe Islands, the infrequent enrollment of CABG patients in CR programs, coupled with transportation challenges, particularly pronounced in the unique Faroese environment, evidently affects CABG patients, resulting in insufficient rehabilitation. Given the lack of prior use of the b-near in this context, it is essential to explore its applicability for the patient group before considering implementation. This leads to the following problem statement and connected research questions.

Problem statement

What factors influence the future implementation of the b-near touch screen solution for patients following coronary artery bypass grafting from a patient perspective at Suðuroy Hospital in the Faroe Islands?

Research Questions

- What are the opportunities for implementation in the case?
- What are the barriers to implementation in the case?

2 Theoretical framework

In this chapter, the theoretical framework involving two theories for this study is outlined. The innovation circle, which comprises four phases, serves as a guiding principle, directing the process from problem identification, through creation and experimentation, to clinical implementation. Before reaching the final phase of implementation, this study will utilize the Normalization Process Theory (NPT) to identify potential opportunities and barriers associated with implementing the b-near for CABG patients within a CR program in the Faroe Islands during the exploratory phase.

2.1 Innovation Circle

As the b-near is not specifically designed for telerehabilitation for CABG patients its suitability should be explored before implementation at the Physiotherapy Department on Suðuroy Hospital. To facilitate this exploration, the researchers will employ the Innovation Circle framework developed by Bundsgaard and Hansen [86], which can be used to guide the process from problem identification to clinical implementation.

The Innovation Circle, rooted in user-driven innovation, serves as a model depicting the linear iterative innovation process—from problem identification, artifact creation, experimentation, to implementation [86]. It emphasizes the role of various users and perspectives as catalysts in the innovation process, with the b-near itself serving as the concrete artifact of examination. User-driven innovation involves active user participation in creating and developing new products, services, or solutions. It emphasizes integrating user feedback, needs, and preferences throughout the innovation journey to ensure resulting innovations effectively meet user requirements and address real-world challenges. In essence, users play a central role in driving the innovation process, from ideation to implementation. Innovation does not solely stem from technology; rather, it emerges through the collaborative engagement of users and decision-makers. Their involvement is critical for bridging the gap between overarching visions and practical realities, highlighting the significance of user-driven approaches [86].

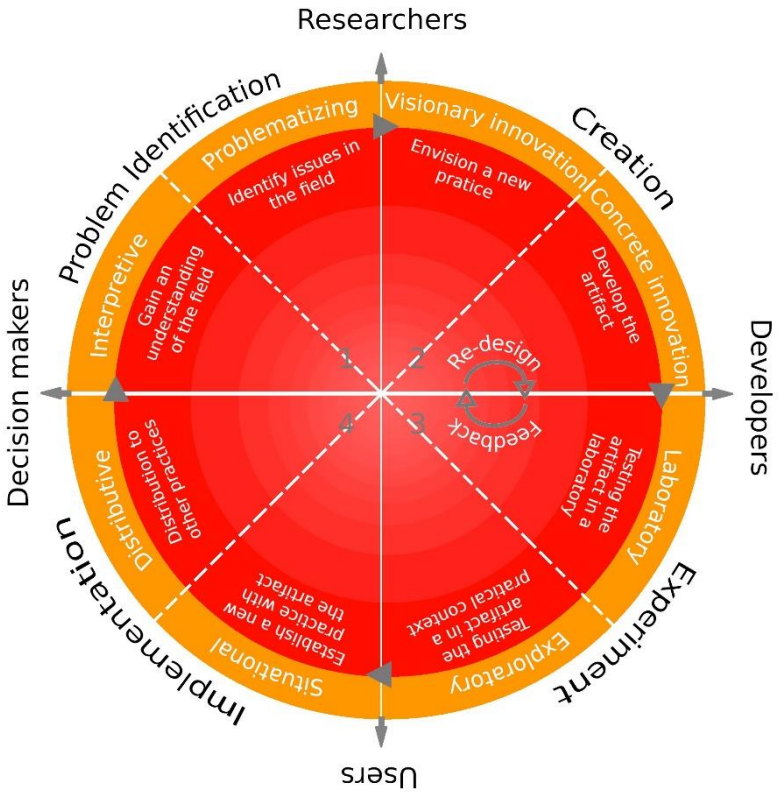

Figure 7 Modified version of the Innovation Circle

Figure 7, modified by the researchers, illustrates the linear-iterative operation of the Innovation Circle, depicting a progression from problem identification, through creation and experimentation, to implementation. It recognizes the iterative nature inherent in innovation, wherein the development of artifacts typically entails multiple cycles of testing, evaluation, and refinement. This iterative approach emphasizes the significance of ongoing improvement and adaptation throughout the innovation process. The orange band indicates sub-phases within each main phase, with descriptions provided on the outer edge of the circle. The two axes specify which participant holds centrality within each part of the process. Consequently, researchers assume a central role in phases 1 and 2, developers in phases 2 and 3, users in phases 3 and 4, and decision-makers in phases 4 and 1 [86]. Further explanation of the main phases of the model will be provided below in the context of this project.

2.1.1 Problem Identification

In the problem identification phase, the focus is on observing, participating in, and reflecting on practices to gain a deeper understanding and identify areas for improvement. This may involve pinpointing more suitable goals, enhancing participation, improving productivity, and other related aspects. Both researchers and reflective practitioners contribute to identifying problems and proposing better practices [86].

The problem identification phase comprises two key aspects: the interpretive phase and the problematizing phase. During the interpretive phase, the researchers of this study systematically examined literature to gain empathy and a deeper understanding of the problem field. In the problematizing phase, which is often closely intertwined with the interpretive phase [86], a more skeptical and critically distant approach was adopted to identify a problem through thorough examination.

2.1.2 Creation

The creation phase is central to user-driven innovation, comprising two distinct phases that represent varying levels of generalization. In the first phase, known as visionary innovation, innovators envision a changed or entirely new practice. This phase results in the creation of secondary artifacts, such as conceptual visions that depict the transformed practice. Although intangible, these conceptual objects serve as mental models for the envisioned practice [86]. In this project, secondary artifacts involved the concept of utilizing the b-near to address the insufficient amount of CR for CABG patients at Suðuroy Hospital, potentially impacting both patients and the Faroese healthcare system.

In the second phase, referred to as concrete innovation, developers translate these visions into tangible primary artifacts—objects that users can interact with. These primary artifacts typically take the form of prototypes or mock-ups initially. Collaboration between innovators and developers occur during this phase [86]. In this project, the b-near served as the primary artifact, intended for simultaneous use by both HPs and Faroese CABG patients. To ensure the technology's suitability for both groups, technology demonstration meetings were held with users to discuss and refine the design of the b-

near. User input shaped the technology for the Faroese context, with developers integrating these changes into the final prototype used in the study.

2.1.3 Experiment

The experimentation phase involves testing and enhancing artifacts, such as prototypes and other designs [86]. In this study, it involves exploring the factors that influence the implementation of the b-near as an assistive tool for CABG patients in a CR program prior to its actual implementation. This phase is divided into two parts: a laboratory phase, where the artifacts are tested in a controlled laboratory setting with end users, and an exploratory phase, where the artifacts are integrated in a practical context relevant to the end users [86]. As in the concrete innovation phase, the suitability of the b-near for the Faroese context was assessed by health care staff in the laboratory phase, as well as by the researchers themselves in various settings. User participation is crucial in this phase, as users actively shape subsequent iterations and guide redesign efforts based on discussions about the envisioned practice. This dynamic involvement is depicted by the circling arrows shown in Figure 7, illustrating the iterative nature of the process [86].

In the exploratory phase, which serves as the scope of this study, potential opportunities and barriers associated with implementing the b-near for CABG patients within a CR program in the Faroe Islands will be explored. The aim is to assess their potential contribution to realizing the envisioned practice identified in the visionary innovation phase in regard to future implementation. To explore these factors another theory will be utilized outlined in section 2.2.

2.1.4 Implementation

In the implementation phase, the culmination of the innovation process occurs as the new idea is put into action. The Organisation for Economic Co-operation and Development (OECD) defines innovation as ‘the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organization or external relations’ [87]. Decision-makers are central in this phase, representing the final category of actors. Their importance becomes evident when distinguishing between the two key implementation phases: situational and distributive. In the situational phase, primary end-users (such

as patients and HPs) are paramount, while in the distributive phase, decision-makers assume primary importance due to their leadership support and the necessity of systematic innovation for widespread implementation [86].

2.2 Normalization Process Theory

To address the potential of the final phase of the Innovation Circle, this study adopts the NPT. NPT is a dynamic action theory designed to understand the processes and actions required for implementing new healthcare technologies into everyday practice. Unlike approaches that solely focus on individual attitudes and beliefs, NPT emphasizes practical aspects, ensuring the seamless operationalization of these technologies and their sustained integration into existing workflows [88, 89]. NPT facilitates comprehension of the dynamics influencing the implementation of a telerehabilitation device for CABG patients in a rehabilitation program, thus revealing innovative approaches to enhancing healthcare systems [89]. Understanding how emerging technologies become integrated into routine practice holds significant importance for researchers, clinicians, health service managers, and policymakers [89]. Moreover, NPT extends beyond the initial stages of implementation, delving into later phases where an intervention becomes deeply rooted in routine practice, essentially blending seamlessly into the background—a phenomenon known as normalization [88].

The implementation of a telerehabilitation device into clinical practice can be a prolonged process spanning several years, requiring ongoing dynamic assessment before it becomes a routine component of workflow. NPT offers a conceptual framework that clarifies the implementation process, guiding the operationalization and long-term sustainability of telerehabilitation technology in practical settings [89]. This study will employ NPT in the exploratory phase of the innovation circle to guide the process of data collection, coding and data analysis [88]. This is depicted in figure 8 below.

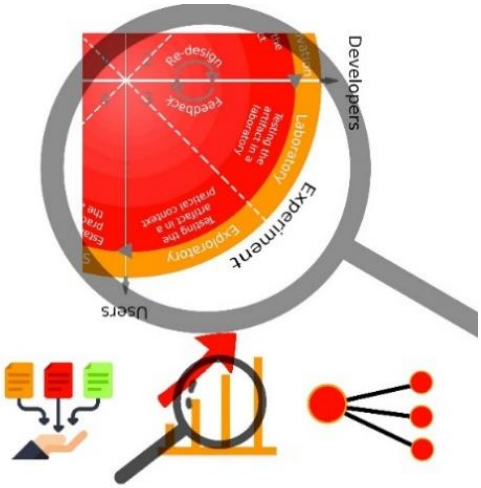

Figure 8 Scope of the exploratory phase

NPT comprises four main components: coherence, cognitive participation, collective action, and reflexive monitoring [88].

Coherence	**Cognitive Participation**
Differentiation	*Initiation*
Communal Specification	*Enrollment*
Individual Specification	*Legitimization*
Internalization	*Activation*
Collective Action	**Reflexive Monitoring**
Interactional Workability	*Systemization*
Relational Integration	*Communal Appraisal*
Skill set Workability	*Individual Appraisal*
Contextual Integration	*Reconfiguration*

Table 1 NPT main components and sub-components

These components will be utilized to inspire the creation of an interview guide, code trees and represent the specific work necessary to ensure a seamless and successful implementation process. They can aid in integrating the intervention, the b-near in this instance, into routine practice. Furthermore, each main component is supplemented with four additional sub-components [89], which will be employed for the analysis of the data collected and are further elaborated below.

2.2.1 Coherence in the context of implementing new practices relates to the process through which individuals or groups comprehend and make sense of the situation. Differentiation involves recognizing and understanding the nuances and distinctions between various practices and their associated components. Communal Specification underscores the collaborative effort in constructing

a collective understanding, whereas Individual Specification adds a personalized layer to this process of sense-making. Internalization encompasses the comprehension and internalization of the value, benefits, and significance of the practices being implemented. Essentially, coherence represents a multifaceted endeavor in the implementation process, seamlessly integrating differentiation, communal specification, individual specification, and internalization [89, 90].

2.2.2 Cognitive Participation involves the relational work involved in establishing and maintaining a cohesive group dedicated to a complex endeavor, such as the adoption of a new technology. Initiation relates to the critical task of ensuring that key participants take the lead in advancing practices. Enrollment requires active and collective participation from all parties involved. Legitimation focuses on fostering belief and support among participants for the initiative. Activation involves collaboratively defining actionable steps for the continuous practice of the initiative. In summary, cognitive participation encompasses initiation, enrollment, legitimation, and activation [89, 90].

2.2.3 Collective Action involves the practical implementation of rules or procedures. Interactional Workability addresses the dynamics of interpersonal interaction during the implementation of practices. Relational Integration emphasizes the establishment of accountability and confidence within the group. Skill set Workability includes the allocation of tasks based on individuals' abilities. Contextual Integration involves effectively managing resources in the given context [89, 90].

2.2.4 Reflexive Monitoring involves assessment of the effects of implementing new practices. Systematization involves participants formally or informally assessing effectiveness. Communal Appraisal entails collaborative evaluation efforts, while Individual Appraisal centers on personal assessments. Reconfiguration stems from the appraisal process, prompting individuals or groups to adjust practices or potentially reshape new technologies [89, 90].

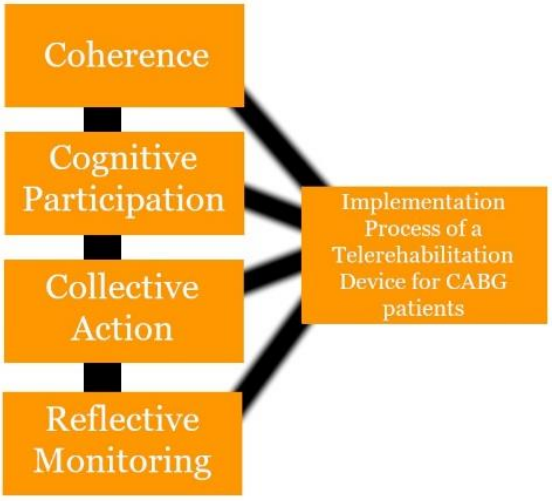

Figure 9 Dynamic relationship between components of NPT

It is crucial to emphasize that the main components maintain dynamic relationships not only with each other but also with the broader context surrounding the implementation of the telerehabilitation device, as illustrated in Figure 8. This context encompasses organizational settings, structures, social norms, group processes, and conventions [88].

3 Methodology

This chapter offers a comprehensive overview of the study's methodology, encompassing aspects such as research design, researchers' preunderstanding, literature search, data collection methods, ethical considerations, subject recruitment, and data analysis methods.

3.1 Design

This research project employs a qualitative case study design [91] to investigate the factors that emerge from exploring the b-near as an assistive tool for patients following CABG, in regard to future implementation on Suðuroy Hospital in the Faroe Islands. This design was chosen to align with the research objectives and enable exploration of real-world phenomena within their natural setting. In this particular case, participants were offered a 3-month CR program at Suðuroy Hospital, which included the use of the b-near, commencing on March 14, 2024. The CR program was carried out by two physiotherapists working at the Physiotherapy Department. Scheduling of either CBCR or b-near training sessions were done autonomously by the physiotherapist fitting their natural working schedule. This approach is invaluable for gaining a comprehensive understanding of how a particular technology functions or influences individuals in their day-to-day activities. Unlike quantitative methods, which frequently rely on controlled laboratory environments, case studies offer unique opportunities to observe and analyze technology's practical application in real-world scenarios, providing valuable insights into factors affecting implementation [91].

3.2 Preunderstanding

Each male researcher holds a distinct bachelor's degree in healthcare. One researcher graduated with a bachelor's degree in occupational therapy, while the other obtained a bachelor's degree in physiotherapy and gained two years of clinical work experience with a diverse range of patients, including those who underwent CABG. These varied backgrounds may influence the researchers' preunderstanding, necessitating the bracketing of preconceptions during data collection to ensure objectivity and access the participants' lifeworld and the meaningful phenomena they experience. This approach focused on understanding the world as perceived by the participants, rather than formulating hypotheses or theories about it [92].

3.3 Literature Search

The foundation of this study was built upon scientific articles and publicly accessible resources. Initial background knowledge was gathered through non-systematic searches and chain searches, revealing a gap in the existing literature on CR for CABG patients. To address this gap, a more systematic approach was adopted. A distinct systematic search was conducted across various databases, including Scopus, Google Scholar, Web of Science, IEEE, Embase, PubMed, and CINAHL. The aim of the search was to explore current research pertaining to the implementation of telerehabilitation devices for CABG patients. The search terms were determined according to the research question outlined in the search protocol (see appendix B) customized for each specific database. The search strategy was adapted into four blocks. Thesaurus and/or candidate terms were used to search broadly within each topic. Phrase searching was employed to include the entire phrase in the search, and truncation was used to capture all potential endings and inflections of the relevant search term. Boolean operators were utilized, where the search terms were combined with "OR" to broaden the search strategy, and the blocks were combined with "AND" to delineate the search strategy. Further details on the methodology of the search are provided below.

3.3.1 Systematic Search

The primary objective of the systematic search was to uncover any prior research on the implementation of a telerehabilitation device for CABG patients.

The in- and exclusion criteria is outlined in Tabel 3, guided the selection process.

Systematic Search	
Inclusion	**Exclusion**
Articles or studies focusing on the implementation of a telerehabilitation device for coronary artery bypass graft patients.	No mentioning of implementing a telerehabilitation device.
Articles or studies in English, Danish, Norwegian or Swedish.	Lack of full-text accessibility.
	Not solely CABG patients

Table 2 Inclusion and exclusion criteria for the systematic search

Search terms used for PubMed is presented below. For search terms for other databases see appendix B.

- Block 1: “Telerehabilitation” [MeSH], Telerehabilitation*, "Tele-rehabilitation*", "Remote Rehabilitation", "Virtual Rehabilitation", “Telemedicine” [MeSH], “Virtual Medicine”, "Telehealth", "eHealth, "Telecare", "Tele-Intensive", "Tele-ICU", "Mobile Health", "mHealth", "digital health", "virtual health", "virtual care"

- Block 2: CABG, "Coronary artery bypass surgery", "Coronary artery bypass Graft", “Coronary Artery Bypass” [MeSH]

- Block 3: “Home”, “Home-based”, “Home based exercise”, “Home based exercise program”

- Block 4: "Implement*", “Implementation science” [MeSH]

3.4 Data Collection Techniques

The study is centered around a single case conducted in the Faroe Islands, employing a triangulation approach to data collection. This includes document materials, interviews, and observation. Data collection was scheduled for four-five weeks after commencing the CR programs.

3.4.1 Document Materials

In the process of establishing a background understanding, various document materials, including technology manuals, reports, internal notes, websites, and scientific studies related to CABG, telemedicine, cardiac rehabilitation, the Faroe Islands, policies, and relevant sources, were consulted [91]. The aim of reviewing these document materials was to establish a foundational understanding of implementing a telerehabilitation device for CABG patients in the Faroe Islands.

3.4.2 Interviews

The primary objective of choosing interviews as a method of data collection was to obtain valuable insights into the factors influencing the implementation of a telerehabilitation device for CABG patients in the Faroese case study. Prior to conducting the interviews, an interview guide was crafted to ensure consistency and structure in questioning (see Appendix C). This guide was carefully crafted to formulate questions based on theoretical preunderstanding, ensuring alignment with the problem

statement and research objectives while maintaining a cohesive narrative. The dynamic nature of the interview guide was shaped by the NPT framework, which directed the course and framing of questions during the interviews. This approach ensured that the interviews were driven by both data and informed by theory. Consistent with the chosen epistemological standpoint, open-ended questions were carefully formulated throughout this process [92].

3.4.2.1 Semi-structured Interviews

The semi-structured interview was selected for its flexibility, allowing for deviations from the interview guide. This flexibility accommodates insights from the participant's lifeworld and experiences, facilitating the interpretation of the meaning of the described phenomena [92]. Each interview was allocated a 30-minute time slot and conducted in Danish at either Suðuroy Hospital or in the participants' homes. Recordings of the interviews were made using a smartphone and later transferred and securely stored on an encrypted USB device.

3.4.3 Observation

Observation was chosen as a method of data collection due to its established effectiveness in providing insights into the participants under investigation. Specifically, when examining CABG patients using a telerehabilitation device in a rehabilitation program, observing participants in action yielded invaluable data to complement individual interviews within the case study. Additionally, observations offer new dimensions for understanding the practical application of new technologies and identifying challenges encountered [91].

Conducted within participants' homes, the observations aimed to highlight the contextual dynamics surrounding screen interaction during the b-near training sessions. Each participant underwent individual observation during a randomly scheduled training session, facilitated by both researchers to enhance observational reliability [91]. Utilizing a direct non-participant observation approach minimized interactions with participants during sessions, enabling researchers to maintain objectivity and record observations through notation of field notes [93].

3.4.3.1 Semi-structured Observations

Semi-structured observations were employed to guide the data collection process, inspired by Mintzberg's principles. According to Mintzberg, this approach facilitates the collection of specific data while still allowing for open-ended exploration. Furthermore, excessive structuring can hinder the ability to comprehend unfamiliar phenomena, while insufficient structure may lead to challenges in recording crucial data and replicating the research findings [94].

To apply this approach effectively, a semi-structured observation guide was developed, drawing inspiration from Fix et al.'s template [95]. This guide provided a structured section for capturing specific elements, such as participants' challenges in accepting calls through the b-near screen and the placement of the screen in their home. These elements were selected based on the insights gained from healthcare staff and the researchers who tested the technology. Additionally, it featured an unstructured field for recording spontaneous, open-ended field notes (for observation guide see appendix D). This dual approach ensured adaptability in data collection while maintaining a framework for systematic observation [95]. The data recorded was gathered using Microsoft Word and later transferred and securely stored on an encrypted USB device.

3.5 Ethical Considerations

The study adheres to the principles outlined in the Helsinki Declaration [96]. In the Faroe Islands, all participants provided informed consent (see appendix E), with their identities protected through anonymization.

3.5.1 Justification and Signification for the Study

This case study is driven by the pressing need to address the lack of adequate CR following CABG, a concern that profoundly impacts both patients and healthcare systems. It aims to explore the factors influencing the future implementation of telerehabilitation technology tailored for HBCR among CABG patients. Currently, limited exploration of this technology's utilization in clinical practice for this population creates a knowledge gap. Through document materials, observation, and in-depth interviews, this research aims to not only enhance the well-being of CABG patients but also to contribute to healthcare literature by investigating the global implementation of telerehabilitation

technology. This study holds practical significance, offering potential advancements in patient care and outcomes, while maintaining a steadfast commitment to the safety, comfort, and ethical treatment of all research participants.

3.5.2 Risk/Benefit Assessment

Participation in this study poses no significant physical risks for the CABG patients. The primary advantages include deeper comprehension of telerehabilitation device implementation for CABG patients, potentially averting decline for patients and enhancing their quality of life. Though immediate benefits are not realized, the acquired knowledge holds promise for future advancements in patient care and outcomes.

3.5.3 Expected and Unexpected Side Effects from the Study

Participation in this study by CABG patients was not expected to entail significant physical risks. Nonetheless, the research team implemented measures to address any potential discomfort, stress, or emotional distress participants might encounter during their engagement. Adhering to ethical principles delineated in the Helsinki Declaration [96], the study prioritized participants' rights, safety, and confidentiality. In the rare event of emergencies or severe distress, prompt and appropriate actions were prepared to safeguard participants' well-being.

3.6 Recruitment of Participants

The Faroese case was intentionally selected to thoroughly investigate the problem statement and research questions. Participants within this case were chosen based on their relevance to the study's research focus.

3.6.1 Number of Participants

The number of participants was determined by the complexity of the research inquiries and the desire of attaining saturation, where additional participants did not significantly contribute new insights. Participant selection followed a criterion-based sampling method, a specific type of purposeful sampling, ensuring alignment with the case's research objectives for each participant [91]

3.6.2 Recruitment Process

Participants for the study were recruited from the Physiotherapy Department at Suðuroy Hospital, Faroe Islands, using a recruitment advertisement written in Faroese (see appendix F) and a document providing participation information in Danish (see appendix G). These were distributed by the staff at the department.

All recruited participants in the case were included based on the criteria depicted below.

Case	
Inclusion	**Exclusion**
Post-CABG patients enrolled in a CR program at Suðuroy Hospital	Inability to speak Danish or English
HPs involved in CR for post-CABG patients at Suðuroy Hospital	Lack of informed Consent

Table 3 Inclusion and exclusion criteria for the case

3.7 Data Analysis

In the following section, the procedures for data processing and analysis are outlined. The empirical data collected underwent examination using NVivo version 12.0 (QSR International, Melbourne, Australia) [97], a specialized qualitative data analysis software tool. This tool was utilized for transcribing, coding, condensation and interpreting observations and interviews conducted in the case as part of this study. A code tree was designed and subsequently analyzed based on Kvale and Brinkmann's principles [92]. This approach helped in identifying and interpreting key themes, concepts, and patterns within the data. Both researchers coded the data.

3.7.1 Preparation of Collected Empirical Data Prior to Analysis

Before transcribing the interviews, a transcription key was developed to ensure consistency, thereby maintaining a consistent approach throughout the transcription process (see Appendix H). This standardized method of handling data facilitates comparison and analysis. In accordance with the research goals, the transcriptions focused on content, excluding articulations, gestures, filler words, repetitions, and non-relevant sounds unless they held significance.

3.7.2 Meaning Coding

Meaning coding was employed to organize and unify observations and participant statements, while a code tree for each dataset was constructed to clarify the significance of the codes and maintain consistency [92]. Both code trees were created inspired by the four main components of NPT. The main aim of the meaning coding was to create categories that thoroughly capture the richness of the examined experiences and actions [92]. Utilizing an exploratory method, the categorization prioritized emerging categories through ongoing reflection and alignment.

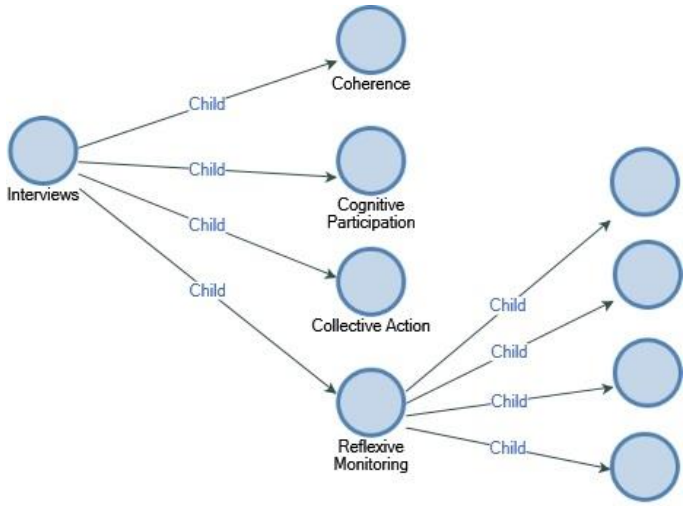

Figure 10 Code tree from NVivo 12 [97]

3.7.3 Condensation

Following the completion of meaning coding, the statements from the interviews provided by the participants and observations underwent a condensation process. This process involved summarizing the conveyed meaning into more concise formulations. Lengthy statements and field notes were condensed into brief expressions, capturing the main essence of the content [92].

3.7.4 Interpretation

Interpretation plays a crucial role in qualitative analysis, aligning with Kvale and Brinkmann's emphasis on uncovering deeper meanings [92]. The interpretation process involved summarizing the analytical text within each respective code group. Drawing from Kvale and Brinkmann's analysis-

interpretation method, inspiration was derived to investigate the meaning of texts across three interpretation contexts as illustrated in Table 4 below [92].

Three interpretation contexts		
Self-understanding	Critical commonsense understanding	Theoretical understanding

Table 4 Three interpretation contexts from Kvale and Brinkmann's analysis-interpretation method

4 Findings

This chapter provides an overview of the findings discovered from the interviews and observations in the case study. First, a demographic overview is presented, detailing the characteristics of the participants involved in the study. These are followed by the findings from the interviews and observations, which explore opportunities and barriers linked to the implementation of the b-near for CABG patients at the Physiotherapy Department of Suðuroy Hospital in the Faroe Islands.

4.1 Recruited Participants

A total of 8 participants were successfully recruited, of whom 1 participant was excluded during the start of the CR program due to absence. There were no dropouts during the rest of the CR period itself leaving 7 participants. Below is a flowchart illustrating the recruitment of participants.

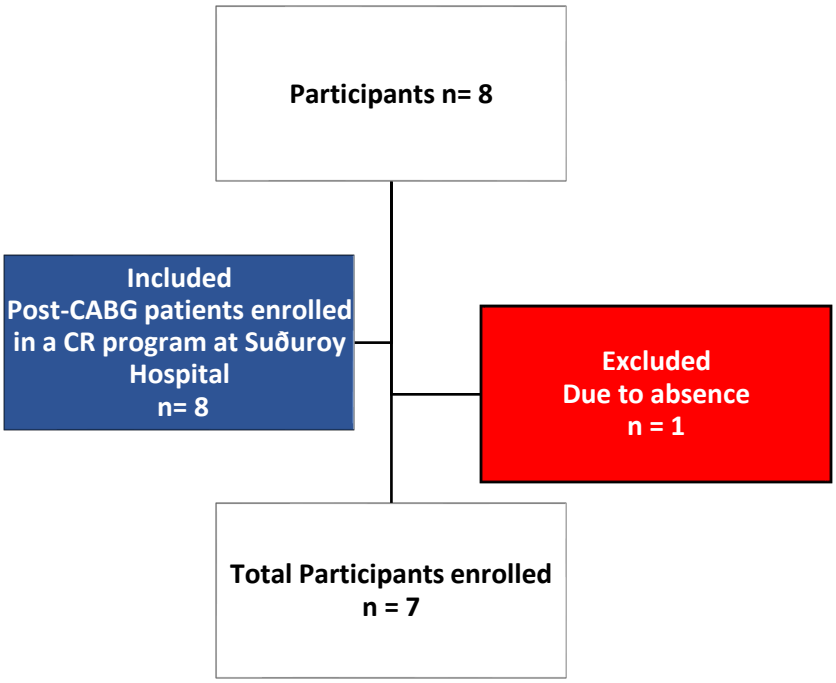

Figure 11 Flowchart of the participants' recruitment in the project

4.2 Demographic Overview

A total of 7 informants were involved in the interviews and observations, collectively averaging an age of 70.43 years. The group comprised exclusively males, encompassing mostly retired individuals and varying years since undergoing CABG procedures. These demographic insights were extracted

from semi-structured interviews. For a comprehensive overview of the participants' demographic details, including participant ID, gender, age, occupation, and year of CABG, please refer to Table 5.

Demographic Table				
Participant ID	**Gender**	**Age**	**Occupation**	**Year of CABG**
P1	Male	83 years	Retired	2018
P2	Male	64 years	Shop assistant	2023
P3	Male	70 years	Retired	2016
P4	Male	69 years	Retired	2023
P6	Male	67 years	Retired	2022
P7	Male	72 years	Retired	2022
P8	Male	68 years	Retired	2020

Table 5 Demographic data from the case

Below presents the overall findings of data from the case study, focusing on exploring the potential opportunities and barriers associated with implementing the b-near for CABG patients at the Physiotherapy Department of Suðuroy Hospital in the Faroe Islands. Throughout the findings, participants are identified by their participant ID.

4.3 Findings from the Interviews

In this section, the interview findings regarding opportunities and barriers in implementing the b-near for CABG patients at the Physiotherapy Department of Suðuroy Hospital in the Faroe Islands are presented. The findings were based on transcriptions totaling 105 pages. Three participants were accompanied by their wives during the interviews. The wives were instructed to remain passive throughout the interview.

4.3.1 Opportunities in Implementing the b-near for CABG Patients in the Case Study

The findings from the opportunities in implementing the b-near for CABG patients at the Physiotherapy Department of Suðuroy Hospital in the Faroe Islands stem from quotes obtained during semi-structured interviews. These findings were condensed into the following themes.

- b-near facilitates training for CABG patients
- b-near facilitates understanding between HP and Patient
- Patients can manage b-near without difficulty
- b-near eliminates the need for transportation to hospital

Table 6 presents a breakdown of these themes, including subthemes and relevant quotations, providing a comprehensive overview of the identified opportunities in implementing the b-near for CABG patients at Suðuroy Hospital.

Opportunities		
Theme	**Subtheme**	**Quotations**
b-near facilitates training for CABG patients	Can be used for exercises	*"It's still just those exercises, with elastic bands. It's the one where you use both the legs and the arms and everything up and down."* (P3)
	CABG patients benefit from b-near training	*"So, the training here really elevates the pulse, and I think that's probably good for myself."* (P6)
b-near facilitates understanding between HP and Patient	Enables understandable Communication between HP and patient	*"We find it very easy to talk to each other"* (P8)
	Can be used for HP and patient to observe each other	*"She sees me, and I see her, and she calls. So, it couldn't be better."* (P3)
Patients can manage b-near without difficulty	The patient can use the b-near for telerehabilitation sessions	*"But that screen, there's only one, it's as simple as it can be. And it should be that way too"* (P7)
	b-near becomes a part of the patients' everyday life	*"So, it became a part of the family, that screen."* (P8)
b-near eliminates the need for transportation to hospital	b-near overcomes rough weather transportation issues	*"So, if it's stormy and the weather is bad. You can't drive, so you just don't drive."* (P7)
	Less transportation is convenient for CABG patients	*"Yes, I think it's fine since there are many who can't get to the hospital. There are several who live on other islands that don't have a hospital. It would be perfect."* (P4)

Table 6 The themes, subthemes, and quotes of the opportunities from the interviews

4.3.2 Barriers for Implementing the b-near for CABG Patients in the Case Study

The findings from the barriers for implementing the b-near for CABG patients at the Physiotherapy Department of Suðuroy Hospital in the Faroe Islands stem from quotes obtained during semi-structured interviews. These findings were condensed into the following theme.

- Lack of physical presence can be a barrier

Table 7 presents a breakdown of the theme, including subthemes and relevant quotations, providing a comprehensive overview of the identified barriers for implementing the b-near for CABG patients at Suðuroy Hospital.

Barriers		
Theme	**Subtheme**	**Quotations**
Lack of physical presence can be a barrier	Less social presence using b-near	*"It's better to go out there, then there's a bit of social interaction too. Then there is more. You move from machine to machine, I think that's good."* (P3)

Table 7 The theme, subtheme, and quote of the barriers from the interviews

4.4 Findings from Observations

In this section, the observation findings regarding opportunities and barriers in implementing the b-near for CABG patients at the Physiotherapy Department of Suðuroy Hospital in the Faroe Islands are presented. All 7 participants illustrated in the demographic table were involved in the observations, which totaled around 5.5 hours.

4.4.1 Opportunities in Implementing the b-near in the Case Study

The findings from the opportunities in implementing the b-near for CABG patients at the Physiotherapy Department of Suðuroy Hospital in the Faroe Islands stem from field notes obtained during observations. These findings were condensed into the following themes.

- b-near facilitates training for CABG patients
- b-near facilitates understanding between HP and Patient
- Patients can manage b-near without difficulty

Table 8 presents a breakdown of these themes, including subthemes and relevant quotations, providing a comprehensive overview of the identified opportunities in implementing the b-near for CABG patients at Suðuroy Hospital.

Opportunities		
Theme	**Subtheme**	**Quotations**
b-near facilitates training for CABG patients	Can be used for exercises	*"The physiotherapist instructs him in high leg lifts and asks the patient to increase the pace, which he does."* (P1)
	Can be used to challenge patients physically	*"The patient takes deep breaths. He becomes breathless and sweats on his forehead."* (P3)
b-near facilitates understanding between HP and Patient	Can be used for training instructions	*"The physiotherapist demonstrates the exercise over the screen with verbal instructions, and the patient performs the exercise accordingly."* (P3).
	Enables understandable Communication between HP and patient	*"Even though the patient is further away from the screen and is panting, the patient can still hear the physiotherapist, and vice versa."* (P7)
	Can be used for HP and patient to observe each other	*"The patient can observe what exercises the physiotherapist is doing, which he then imitates himself. The physiotherapist can count repetitions through the screen as she can see the patient."* (P4)
Patients can manage b-near without difficulty	The patient can use the b-near for telerehabilitation sessions	*"The patient presses the screen himself and receives the call. He steps back and waits for the physiotherapist."* (P4)

Table 8 The themes, subthemes, and quotes of the opportunities from the observations

4.4.2 Barriers for Implementing the b-near for CABG Patients in the Case Study

The findings from the barriers for implementing the b-near for CABG patients at the Physiotherapy Department of Suðuroy Hospital in the Faroe Islands stem from field notes obtained during observations. These findings were condensed into the following theme.

- b-near training sound can hinder HP's patient comprehension

Table 9 presents a breakdown of this theme, including subthemes and relevant quotations, providing a comprehensive overview of the identified barriers for implementing the b-near for CABG patients at Suðuroy Hospital.

Barriers		
Theme	**Subtheme**	**Quotations**
b-near training sound can hinder HP's patient comprehension	Speaking simultaneously hinders comprehension for HP	*"The patient sometimes talks over the physiotherapist, and the physiotherapist has to ask the patient to repeat."* (P4)
	Panting speech hinders HP from hearing the patient on screen	*"The physiotherapist asks the patient to repeat, but this is due to panting speech. When the speech is not panting, the physiotherapist responds understandably."* (P7)

Table 9 The themes, subthemes, and quotes of the barriers from the observations

5 Analysis

In this chapter, a thematic analysis is conducted using Kvale and Brinkmann's analysis-interpretation method. This involves analyzing, firstly, the opportunities and, secondly, the barriers for the implementation of the b-near at the Physiotherapy Department at Suðuroy Hospital in the Faroe Islands. For each theme, a critical commonsense understanding is provided first, followed by the participants' self-understanding, and lastly, a theoretical understanding of the theme in regard to NPT. Through the condensation of meaning, the following main themes was identified:

Opportunities for Implementation	
Interviews	**Observations**
b-near facilitates training for CABG patients	b-near facilitates training for CABG patients
b-near facilitates understanding between HP and Patient	b-near facilitates understanding between HP and Patient
Patients can manage b-near without difficulty	Patients can manage b-near without difficulty
b-near eliminates the need for transportation to hospital	
Barriers for Implementation	
Interviews	**Observations**
Lack of physical presence can be a barrier	b-near training sound can hinder HP's patient comprehension

Table 10 Main themes from interviews and observations

In the following section, the main themes will be analyzed and discussed in relation to the case setting.

5.1 Opportunities for Implementation

b-near Facilitates Training for CABG Patients

Participants highlighted the advantages of integrating the b-near into their CR programs, as it facilitated training and could be utilized for exercises. This was observed similarly as participants followed exercise instructions provided by the HP. Moreover, the b-near system not only effectively supported training exercises but also physically challenged participants. Observations revealed participants sweating, panting, experiencing breathlessness, and their faces turning red. Additionally, participants emphasized feeling tangible benefits derived from the b-near training sessions. The following quote from P6 serves as a reference for this theme:

"So, the training here really elevates the pulse, and I think that's probably good for myself." (P6)

In regard to NPT, this theme is analyzed through the reflexive monitoring component. Suðuroy Hospital should systematically document and analyze the data collected from the patient interviews and observations regarding how the b-near facilitates training for CABG patients. This involves organizing the qualitative feedback related to this theme and identifying key insights and patterns. The hospital should also consider supplementing this qualitative data with quantitative measures, such as tracking patient adherence to training programs and monitoring changes in physical fitness metrics over time. The hospital should assemble a multidisciplinary team, including HP's, administrators, and relevant stakeholders, to collectively appraise the findings related to the theme of training facilitation. During this process, the team should discuss the implications of the patient feedback for the implementation of the b-near in CR programs at Suðuroy Hospital. This collaborative appraisal ensures that diverse perspectives are considered, and consensus is reached on the best course of action. While the focus is on the broader context, Suðuroy Hospital should also recognize the individual perspectives of CABG patients regarding how the b-near facilitates their training experience. HPs should engage with patients individually to understand their specific needs, preferences, and challenges related to using the technology for training purposes. This individualized approach allows for tailored interventions and support strategies to optimize the training experience for each patient.

Based on the insights gathered from the patient interviews, observations and the communal and individual appraisals, Suðuroy Hospital should consider making adjustments to its implementation strategy for the b-near. This may involve refining training protocols to better leverage the technology, providing additional resources or support to enhance patient engagement, or modifying the technology itself to better align with patient preferences and rehabilitation goals. By continuously reconfiguring their approach based on patient feedback, the hospital can ensure that the b-near effectively supports training for CABG patients.

b-near Facilitates Understanding Between HP and Patient

Participants emphasized that the b-near system facilitated understanding between HP and themselves. They highlighted the clarity and ease of communication between HP and patients. This was also evident during observations where communication between HP and participants was effective, and training instructions were conveyed clearly, leading to participants performing exercises as instructed. Furthermore, participants noted the effectiveness of being able to observe each other through the b-near screen during training, which enhanced their understanding and collaboration. This was also observed during observations, with visual cues from the b-near screen often used to instruct participants. The following quote from the observation of P4 serves as a reference for this theme:

"The patient can observe what exercises the physiotherapist is doing, which he then imitates himself. The physiotherapist can count repetitions through the screen as she can see the patient."
(P4)

Similarly, within the framework of NPT, the analysis of this theme centers on the reflexive monitoring component. Suðuroy Hospital should systematically document and analyze the data collected from the patient interviews and observations regarding how the b-near system facilitates understanding between HPs and patients. This involves organizing qualitative feedback related to this theme, such as comments on the clarity and ease of communication, observations of effective communication during training sessions, and instances where visual cues from the physiotherapist through the b-near screen were used to instruct participants. The hospital should identify key insights and patterns to inform decision-making. Assembling a multidisciplinary team to collectively appraise these findings ensures diverse perspectives are considered in decision-making. During this process, the team should discuss the implications of the patient feedback for the implementation of the b-near in CR programs. They should evaluate how the technology enables communication between HP and patients, facilitates training instructions, and promotes collaboration. This collaborative appraisal ensures that diverse perspectives are considered in decision-making. Alongside the broader context, Suðuroy Hospital should also recognize individual perspectives of CABG patients regarding how the b-near screen facilitates understanding between HP and themselves. HPs should engage with patients individually to understand their specific experiences, preferences, and challenges related to using the technology for communication during training sessions. This individualized approach allows for

tailored interventions and support strategies to optimize communication and understanding for each patient.

Based on the insights gathered from the patient interviews, observations, and communal and individual appraisals, Suðuroy Hospital should consider making adjustments to its implementation strategy for the b-near. This may involve refining communication protocols to better leverage the technology, providing additional training or resources to enhance communication skills among HPs, or modifying the technology itself to better meet the communication needs of patients. By continuously reconfiguring their approach based on patient feedback, the hospital can ensure that the b-near effectively facilitates understanding between HP and patients.

Patients Can Manage b-near Without Difficulty

Participants emphasized their ease of use and manageability of the b-near, stating that they encountered no difficulties. They found the screen simple and straightforward to use during telerehabilitation sessions. This ease of use was also observed during observations, as all participants were able to initiate and complete the telerehabilitation sessions without difficulty. Additionally, participants noted that the b-near seamlessly integrated into their everyday lives, with one even stating that the b-near screen had become a part of their family. The following quote from P7 serves as a reference for this theme:

"But that screen, there's only one, it's as simple as it can be. And it should be that way too" (P7)

Regarding NPT, the analysis of this theme through the reflexive monitoring component requires systematic documentation and analysis of data collected from patient interviews and observations. The focus is on understanding how patients perceive the ease of managing the b-near. This involves organizing qualitative feedback related to this theme, such as comments on the simplicity and straightforwardness of the screen, observations of participants initiating and completing telerehabilitation sessions without difficulty, and instances where the b-near seamlessly is integrated into patients' everyday lives. The hospital should identify key insights and patterns to inform decision-making. Assembling a multidisciplinary team to collectively appraise the findings related to the theme

of manageability ensures diverse perspectives are considered in decision-making. During this process, the team should discuss the implications of the patient feedback for the implementation of the b-near in CR programs. They should evaluate how the technology's ease of use impacts patient engagement, adherence to rehabilitation protocols, and overall satisfaction. This collaborative appraisal ensures that diverse perspectives are considered in decision-making. Suðuroy Hospital should also acknowledge the individual perspectives of CABG patients regarding their experiences managing the b-near. HPs should engage with patients individually to understand their specific experiences, preferences, and challenges related to using the technology. This individualized approach allows for tailored interventions and support strategies to optimize patient experience and satisfaction.

Based on the insights gathered from the patient interviews, observations, and communal and individual appraisals, Suðuroy Hospital should consider making adjustments to its implementation strategy for the b-near. This may involve providing additional training or resources to ensure patients feel confident in managing the technology independently or incorporating patient feedback into the design of future iterations of the b-near. By iteratively reconfiguring their approach based on patient feedback, the hospital can ensure that the b-near remains easy to use and seamlessly integrated into patients' lives.

b-near Eliminates the Need for Transportation to Hospital

Participants emphasized that the b-near system eliminates the need for transportation to the hospital, presenting several opportunities, particularly in the challenging Faroese environment. The system offers a solution to the unique transportation issues caused by rough weather conditions, which often influence participants' decisions to drive to the hospital. This is especially relevant for older individuals who may feel unsafe driving in stormy weather. Furthermore, participants highlighted the convenience of reduced transportation. The b-near system could serve as a valuable aid for patients residing in remote areas and islands without nearby hospitals. The following quote from P7 serves as a reference for this theme:

"So, if it's stormy and the weather is bad. You can't drive, so you just don't drive." (P7)

Concerning NPT, this theme is analyzed through the reflexive monitoring component. Suðuroy Hospital should systematically document and analyze the data collected from the patient interviews regarding how the b-near system eliminates the need for transportation to the hospital. This involves organizing qualitative feedback related to this theme, such as comments on the convenience of reduced transportation, challenges posed by rough weather conditions, and opportunities presented by the b-near system for patients in remote areas or islands without nearby hospitals. The hospital should identify key insights and patterns to inform decision-making. The hospital should assemble a multidisciplinary team, to collectively appraise the findings related to the theme of eliminating the need for transportation. During this process, the team should discuss the implications of patient feedback for the implementation of the b-near system in CR programs. They should evaluate how the technology's ability to eliminate the need for transportation impacts patient access to care, engagement in rehabilitation programs, and overall satisfaction. This collaborative appraisal ensures that diverse perspectives are considered in decision-making. Suðuroy Hospital should also recognize the individual perspectives of CABG patients regarding their experiences with eliminating the need for transportation. HPs should engage with patients individually to understand their specific experiences, preferences, and challenges related to using the technology to access care remotely. This individualized approach allows for tailored interventions and support strategies to optimize patient access and satisfaction.

Based on the insights gathered from the patient interviews and communal and individual appraisals, Suðuroy Hospital should consider making adjustments to its implementation strategy for the b-near system. This may involve expanding the reach of telerehabilitation services to target patients in remote areas or islands, providing additional support resources to ensure patients feel comfortable using the technology remotely, or collaborating with local community organizations to facilitate access to the b-near system for underserved populations. By continuously reconfiguring their approach based on patient feedback, the hospital can ensure that the b-near system effectively eliminates transportation barriers and improves patient access to care.

5.2 Barriers for Implementation

Lack of Physical Presence Can Be a Barrier

The participants stressed that the absence of physical presence when using the b-near could pose a barrier. This concern was exemplified by a participant who noted a reduction in social interaction while using the b-near compared to training at the hospital. The following quote from P3 serves as a reference for this theme:

"It's better to go out there, then there's a bit of social interaction too. Then there is more. You move from machine to machine, I think that's good." (P3)

Regarding NPT, this theme undergoes analysis via the reflexive monitoring component. Suðuroy Hospital should systematically document and analyze the data collected from the patient interviews regarding the theme on how the lack of physical presence when using the b-near could pose a barrier. This involves organizing qualitative feedback related to this theme, such as comments on the reduction in social interaction, challenges associated with virtual training compared to in-person sessions, and concerns about the impact on motivation and engagement. The hospital should identify crucial insights and patterns to guide decision-making. The hospital should assemble a multidisciplinary team, comprising HPs, administrators, and pertinent stakeholders, to collectively evaluate the findings concerning the theme of physical presence as a barrier. During this process, the team should discuss the implications of patient feedback for the implementation of the b-near system in CR programs. They should evaluate how the absence of physical presence may impact patient engagement, adherence to rehabilitation protocols, and overall satisfaction. This collaborative appraisal ensures that a variety of viewpoints are taken into account during the decision-making process. Suðuroy Hospital should also recognize the individual perspectives of CABG patients regarding their concerns about the lack of physical presence. HPs should engage with patients individually to understand their specific experiences, preferences, and challenges related to using the technology for virtual training. This individualized approach allows for tailored interventions and support strategies to address concerns and optimize patient engagement.

Drawing from the insights obtained from patient interviews and both communal and individual

appraisals, Suðuroy Hospital should consider modifying its implementation strategy for the b-near system. This may involve implementing strategies to enhance social interaction during virtual training sessions, such as incorporating group exercises or virtual support groups, providing additional motivational support resources, or offering alternative options for patients who prefer in-person sessions. Through continuous reconfigurations based on patient feedback, the hospital can tackle concerns regarding the absence of physical presence and ensure that the b-near system adequately promotes patient engagement in CR programs.

b-near Training Sound Can Hinder HP's Patient Comprehension

During observations, it became apparent that the sound from the b-near training sessions could hinder the HP's comprehension. This was evident as simultaneous speaking made it challenging for the HP to hear and consequently understand what the patient was saying through the screen. Additionally, panting speech resulting from the physical effects of the training could further hinder the HP's ability to hear the patient on screen. The following quote from the observation of P4 serves as a reference for this theme:

"The patient sometimes talks over the physiotherapist, and the physiotherapist has to ask the patient to repeat." (P4)

Regarding NPT, this theme is analyzed using the reflexive monitoring component. Suðuroy Hospital should systematically document and analyze the data collected from the observations regarding how the sound from b-near training sessions can hinder the HPs comprehension. This involves organizing qualitative feedback related to this theme, such as observations of simultaneous speaking and panting speech during training sessions, and instances where the HP had difficulty hearing and understanding the patient through the screen. The hospital should identify key insights and patterns to inform decision-making. The hospital should gather a multidisciplinary team to collectively evaluate the findings concerning the theme of how sound impedes comprehension. During this process, the team should discuss the implications of the observations for the implementation of the b-near system in CR programs. They should evaluate how sound issues impact HP's ability to provide effective guidance and support to patients during training sessions. This collaborative appraisal ensures that

diverse perspectives are considered in decision-making. Suðuroy Hospital should also acknowledge the individual perspectives of CABG patients concerning their encounters with difficulties in comprehension due to sound issues during b-near training sessions. HPs should engage with patients individually to understand their specific experiences, preferences, and challenges related to communication during training sessions. This individualized approach allows for tailored interventions and support strategies to address sound issues and optimize patient understanding.

Based on the insights gathered from observations and communal and individual appraisals, Suðuroy Hospital should consider making adjustments to its implementation strategy for the b-near system. This may involve implementing measures to improve sound quality during training sessions, such as not speaking simultaneously or adjusting volume settings, providing training to HPs on effective communication techniques during virtual sessions, or incorporating visual cues to supplement audio information. By continuously reconfiguring their approach based on feedback, the hospital can address concerns about sound comprehension and ensure that the b-near system effectively supports patient-HP communication in CR programs.

6 Discussion

In this chapter, the project's findings from document materials, interviews and observations are discussed and examined through the project's theoretical framework and insights from relevant scientific studies. The overall goal is to address the problem statement of the project and its underlying research questions:

What factors influence the future implementation of the b-near touch screen solution for patients following coronary artery bypass grafting from a patient perspective at Suðuroy Hospital in the Faroe Islands?

- What are the opportunities for implementation in the case?
- What are the barriers to implementation in the case?

In the opening section, an examination of the case contexts is conducted, followed by a theoretical and scientific exploration of opportunities and barriers in the implementation of the b-near for CABG patients in the case. Finally, the section concludes with reflective insights on the methodology employed throughout the study.

6.1 Suðuroy Hospital

At Suðuroy Hospital's Physiotherapy Department, ongoing trials are investigating the potential application of the b-near for CABG patients. Despite its recognition as an assistive device for intercoms by the Danish Authority of Social Services and Housing's AssistData [81], the b-near has not obtained registration as a medical device under the MDR 2017/745 [85] or MDSW [85].

In the EU, medical devices must secure a CE marking to demonstrate compliance with essential standards and undergo rigorous evaluation, ensuring safety, health, environmental protection, and consumer protection [98] However, the b-near currently lacks this required CE marking for classification as a medical device and may instead be considered a general consumer product. While general consumer products offer cost advantages due to reduced regulatory burdens, potentially increasing affordability and accessibility for consumers, it is essential to acknowledge the potential compromise on safety and effectiveness [99]. Therefore, a careful balance between affordability and safety is crucial in implementing such products in healthcare settings.

However, despite Denmark's EU membership, the Faroe Islands maintain independence from the Union [73], leading to different regulatory considerations. Importers, sellers, and manufacturers must register with the Chief Pharmaceutical Officer and adhere to specific notification and reporting guidelines, with inspections conducted to ensure compliance and penalties for violations. Additionally, advertising standards and disclosure of device defects are mandated by law to prevent misleading information [100].

As the evaluation of the b-near application advances within the ever-changing weather conditions of the unique Faroese archipelago environment, it is crucial to delve into the patients' perspective on the opportunities and barriers associated with implementing the b-near for CABG patients. This study identified various opportunities and barriers within the Faroese healthcare setting, which will be discussed in detail in the following sections.

6.2 Findings Discussion

The results of this study indicate both opportunities and barriers for implementing the b-near for CABG patients at Suðuroy Hospital. When applying the NPT framework to analyze the findings in the case, it becomes evident that the majority of work is currently focused on reflexive monitoring. The participants actively assess and reflect on their experiences using the b-near and the broader implications for the care of CABG patients within the Faroese context [89]. It is unsurprising that the majority of the work being done involves reflexive monitoring, considering that the b-near is still in a trial period at Suðuroy Hospital and not yet implemented in clinical practice at the Physiotherapy Department. Based on the theoretical analysis of the themes, the insights obtained from the study's interviews and observations, as well as the suggested communal and individual appraisals, Suðuroy Hospital should consider making adjustments to its implementation strategy for the b-near system. This assessment work should prove crucial and serve as a steppingstone from the experimental phase to the implementation phase.

Participants in the case study agreed that b-near facilitated their training. This was evident as patients performed their exercises as instructed and experienced being challenged physically during training sessions. This aligns with several studies comparing outcomes in individuals participating in HBCR

and CBCR, consistently reporting similar improvements in peak oxygen uptake and other exercise parameters. This holds true for patients with CVDs and for those undergoing CABG, regardless of whether they are assigned to HBCR or CBCR[101–105]. Improvement in the distance achieved on an incremental shuttle walk test was evaluated in two studies and was similar in HBCR participants and CBCR participants [106, 107]. The improvement in distance achieved on a 6-min walk test was analyzed in two studies and was found to be similar in those participating in HBCR and patients participating in CBCR [102, 108]. Improvements in the peak metabolic equivalent tasks achieved on an exercise test [103, 109] and work capacity on a cycle ergometer [110] were also similar in those assigned to HBCR and those assigned to CBCR. Also, in a randomized controlled trial by Maddison et al. [111] it was demonstrated that telerehabilitation, specifically the remotely monitored exercise-based cardiac telerehabilitation (REMOTE-CR) program, is at least as effective as traditional CBCR in improving various outcomes related to cardiovascular health. These outcomes include maximal aerobic exercise capacity ($\dot{V}O2max$), blood lipid and glucose concentrations, anthropometry (body measurements like height, weight, BMI, waist/hip circumference), blood pressure, physical activity levels, exercise-related motivation, exercise adherence, adverse events, and health-related quality of life (HRQoL).

The majority of participants had previously been diagnosed with myocardial infarction and/or angina pectoris. Additionally, nearly two-thirds had undergone angioplasty, and one-quarter had undergone CABG. REMOTE-CR exhibited significant cost savings compared to CBCR, making it a more economically viable alternative. It is important to note that the b-near is not specifically designed for CR, and that programs like REMOTE-CR incorporate not only real-time video conferencing, but also leverage sensors and other measurement devices to gather vital biomarker data, such as heart and respiratory rates. This approach likely improves outcomes compared to solely relying on video conferencing. However, while the benefits of REMOTE-CR are evident, additional studies are warranted to thoroughly evaluate the efficacy of the b-near for CR.

Participants in the case study acknowledged that the b-near effectively facilitated understanding between HP and patients. This make sense considering that the b-near is specifically designed as a communication solution with a focus on fostering simple yet meaningful communication and closeness among individuals [78–80]. It effectively enables clear communication between HP and

patients during b-near training sessions, as observed in the participants' homes. As highlighted by Rathore et al., successful implementation of a HBCR program relies heavily on patient-level factors such as motivation, self-efficacy, and engagement, which are essential for long-term success [61, 112]. Therefore, individual appraisal work is crucial, as these factors determine the readiness of CABG patients for behavior change, guiding tailored interventions. Effective approaches involve conveying understanding, empathy, and interest in patients, assisting them in accepting the necessity for change, and addressing barriers and challenges influencing their behaviors [113]. The b-near appears to be a promising tool in this regard, although it was noted in the case study that the b-near training sound could impede patients' comprehension, hindering communication between HP and patients. Collaborative appraisal work should thus focus on developing guidelines to instruct patients using the b-near to wait for the HP to finish their spoken sentences before responding and to refrain from replying if experiencing breathlessness.

Participants in this case study agreed that the b-near device could be used without difficulty by the patients, offering promising solutions to usability issues highlighted in the study by Saitoh et al. [64]. Similarly to the REMOTE-CR study by Maddison et al. [111], the study by Saitoh et al. utilizes a variety of measurement devices to gather vital biomarker data, including readings from electrocardiographs, pulse oximeters, and blood pressure monitors, all facilitated through Bluetooth-connected devices. While Saitoh et al.'s study enrolled patients with a certain level of digital literacy, some encountered challenges related to usability or connectivity. The complexity of integrating multiple measurement devices alongside video conferencing may contribute to these issues, suggesting that the b-near could provide a simpler alternative, particularly for elderly CABG patients. However, this potential advantage must be weighed against the benefits of obtaining comprehensive patient data during telerehabilitation sessions. Currently, there is a scarcity of studies evaluating the usability of the b-near specifically for CR or in broader contexts. Nevertheless, insights from this case study suggest its ease of use for CR, which may hold significant weight in the clinical decision-making process. A collective appraisal of these factors is essential and should involve the hospital's multidisciplinary team, including HPs administrators, and relevant stakeholders.

Participants in the case study agreed that the introduction of the b-near effectively eliminated the need for hospital transportation. This has proposed several opportunities, particularly in mitigating challenges posed by the unique Faroese weather conditions. Moreover, the reduction in transportation

requirements could prove highly advantageous for participants, especially for patients residing in remote areas or islands lacking hospital facilities. Consequently, they now have the convenience of conducting CR sessions without the need to travel to the hospital. According to a review conducted by Chindhy et al. [114], HBCR programs, facilitated through methods such as video or telephone conferences with physiotherapists, nurses, or physicians, enhance patient accessibility and overcome numerous obstacles encountered by CBCR programs. Unlike CBCR programs, which typically entail 3–4 hours of scheduled weekly in-person sessions, HBCR services offer the advantage of convenience, enabling participants to engage in rehabilitation activities at their own discretion and from any location. This flexibility eliminates concerns related to commuting distance, travel expenses, time away from work, or childcare responsibilities, ultimately leading to increased participation and completion rates in CR. Furthermore, other research indicates that individuals constrained by time commitments, such as familial or occupational obligations, prefer HBCR over CBCR due to its greater flexibility [115].

One participant highlighted the lack of physical presence as a barrier, noting a reduction in social interaction when using the b-near compared to training at the hospital. This lack of in-person supervision in HBCR can lead to reduced patient accountability and adherence [114]. While remote monitoring and regular feedback from HPs may offer some motivation, they are generally less effective than real-time, in-person feedback [116]. Additionally, individuals grappling with emotional distress, depression, and anxiety often exhibit poorer coping mechanisms and higher dropout rates, potentially rendering them less suitable candidates for HBCR [117, 118]. Moreover, in HBCR, the clinical team's assessment relies heavily on patients' subjective reports, which may not always accurately reflect their condition. Collectively, the group-based dynamics and in-person support inherent in CBCR provide positive social reinforcement to participants, elements that are challenging to replicate in the HBCR setting [114]. Consequently, there is a clear emphasis on the individual appraisal work to accurately identify those best suited for HBCR using the b-near. However, it is crucial to underscore that the purpose of utilizing the b-near as an assistive tool is not to replace in-person training sessions but rather to support patients facing difficulties attending such sessions due to personal challenges.

This case study provides valuable insights into the factors influencing the future implementation of the b-near as an assistive tool for patients following CABG at Suðuroy Hospital in the Faroe Islands.

Uniquely, the Faroe Islands do not adhere to EU legislation on medical devices. This allows for the utilization of a non-medical device like the b-near for telerehabilitation at Suðuroy Hospital. This enhances accessibility for CABG patients, leading to potential optimal outcomes in recovery and quality of life. Moreover, this accessibility, coupled with the predominantly publicly funded Faroese healthcare system operated through taxation [119], eliminates financial constraints such as reimbursement issues among patients, which are significant barriers to accessing healthcare technology worldwide.

This study underscores that insights gathered from the findings, along with communal and individual appraisal work, should be taken into account by Suðuroy Hospital when making adjustments to its future implementation strategy for the b-near system. As the implementation phase approaches, adopting the NPT as a valuable framework can facilitate the process. Normalizing the b-near in clinical practice for CABG patients may require time, potentially spanning several years. While NPT is not a prescriptive blueprint or definitive guide for execution, it offers insights for seamlessly integrating the b-near into routine CABG care. In developing tailored implementation strategies for the b-near rollout, it is acknowledged that NPT promotes a deeper understanding of specific trial components rather than prescribing rigid procedures. This approach permits the combination of various methods and tools, improving adaptability to the unique needs of each case [89].

6.3 Reflections of Methodology

In this section, reflections on the methodology of this study are discussed, including the advantages and disadvantages of the chosen study design, triangulation and data collection measures.

6.3.1 Study Design

Case studies offer in-depth, detailed information that enhances understanding of the phenomenon under study. They allow researchers to delve deeply into real-life situations, shedding light on why certain events unfold as they do [91]. Furthermore, case studies enable researchers to embrace a holistic approach, exploring specific cases from multiple angles and considering various factors. They are crucial in constructing theories, generating hypotheses, or developing theoretical frameworks based on observed patterns and relationships within the case. Renowned for their adaptability, case

study research seamlessly adjusts to diverse research questions and contexts. In real-world settings, researchers often face limited control over variables, making it challenging to establish causation. While direct generalizability to a broader population may be restricted [91], Flyvbjerg [120] disputes the notion that generalization depends solely on large samples and formal statistical methods. He underscores the substantial impact of carefully selected case studies, exemplified by instances like Galileo's challenge to Aristotle's law of gravity. Galileo's dismissal was not rooted in an extensive range of observations but primarily in conceptual and practical experiments. Nevertheless, Aristotle's gravitational theory endured as the predominant scientific viewpoint for nearly 2,000 years until it was eventual proven false. Flyvbjerg's perspective aligns with the idea that a carefully chosen single case study, conducted with depth and strategic intent, can yield significant contributions to scientific knowledge [120].

Although there is an inherent risk of bias and subjectivity in interpreting data, it is crucial to transparently acknowledge the researcher's background's impact. Even with efforts to set aside preconceptions during data collection, understanding the potential influence of these factors on the entire research process is vital. While it is acknowledged that complete objectivity may not be achievable, a reflective approach is taken towards the researchers' own influence [92]. This transparency not only enhances the study's credibility but also prompts readers to critically assess the researcher's perspective in shaping the findings [91]. It is worth noting that Heidegger argued against dismissing experiences regarding the phenomenon under investigation. He argued that personal awareness is inherent to phenomenological research, emphasizing that his position did not advocate for understanding how human knowledge functions. Rather, Heidegger embraced the notion that knowing is fundamental to the essence of being [121]. Additionally, case studies often demand significant time and resources. The analysis of extensive data from a case study introduces complexity to the research process, potentially increasing the analytical workload. Replicating case studies with equivalent detail and context can prove especially challenging due to the unique and context-specific characteristics inherent to each case [91].

6.3.2 Triangulation

In qualitative studies, researchers often use triangulation to enhance the validity and reliability of their findings by cross-validating information from various sources or methods [91]. In this project, multiple forms of triangulation were utilized.

Data triangulation enhanced the construct validity of the case study by generating convergent evidence from interviews, observations, and document analysis. This approach contributed to a cohesive understanding of the phenomenon under study. Investigator triangulation involved both researchers participating in all interviews and observations, ensuring the reliability and credibility of interpretations. Subsequently, the findings were reviewed collaboratively to mitigate individual biases. Roles as either interviewer or observer were assigned during data collection, facilitating observer triangulation throughout the project. This was particularly evident during data analysis, where discussions on coding the empirical material occurred. However, it is acknowledged that agreement during analysis does not necessarily equate to quality. To ensure quality, the transcribed material was revisited to accurately reflect the informants' statements. Being faithful and loyal to the informants' statements has been an important part of the analysis work to ensure credibility. To validate participants' statements, member checking was conducted presenting each individual with their respective formulated quotation and associated interview themes to confirm accuracy. Participants had the opportunity to revise quotations that did not accurately reflect their statements. Member checking occurred in person with six participants and via email with one participant. No revisions were requested by any participant, confirming the validity of the findings. Theory triangulation was achieved by utilizing different theoretical frameworks, namely the Innovation Circle Framework and the NPT. This approach facilitated a comprehensive understanding of the phenomenon by exploring it from multiple angles and interpretations of the data. Methodological triangulation utilized diverse research methods, including interviews, observations, and document analysis, to explore the same problem statement and research questions. By triangulating across these methods, researchers leveraged the strengths of each approach while reducing their individual limitations. Finally, participant triangulation encompassed collecting perspectives from all participants, comprising seven individuals in this instance. This enriched the analysis by capturing diverse viewpoints and experiences [122].

6.3.3 Recruitment of Participants

While criteria were established for participant recruitment, this project employed a purposeful sampling strategy to select participants for the case study. Purposeful sampling is a widely utilized method in qualitative research, aimed at efficiently identifying and selecting information-rich cases, particularly when resources are limited [123]. Unlike random sampling, which seeks to ensure generalizability, purposeful sampling focuses on comprehending a specific phenomenon by selecting cases that offer rich insights [124]. One of the strengths of this sampling strategy lies in its ability to target individuals with relevant information or those deemed key players, thus optimizing efficiency and effectiveness. Factors such as availability, willingness to participate, and the ability to articulate experiences and opinions in a reflective manner, as emphasized by Spradley [125] and Bernard [126], contribute to the success of purposeful sampling. However, it is important to acknowledge that while purposeful sampling maximizes depth of understanding, it may sacrifice representativeness compared to probabilistic sampling methods, which aim for broader generalizability [127].

All seven participants met the established criteria, despite variations in sociodemographic backgrounds. While the gender distribution among participants was balanced, the diversity among participants in other sociodemographic aspects likely enriched the insights gained from the b-near training sessions. This diversity could enhance the applicability of the study findings to a broader audience. However, it is important to acknowledge that all participants were male, which might impact the transferability of the case study findings.

6.3.4 Data Collection Measures

As outlined in the methodology section, the three-month CR programs commenced on March 14, 2024, with data collection taking place four to five weeks after the programs began. Despite the researchers' arrival in the Faroe Islands on March 4, the deployment of the b-near screens was delayed due to customs processing. Consequently, the screens reached the hospital on March 13. Although the physiotherapists initially planned to utilize the b-near weekly starting March 14, various factors, including holidays, personal commitments, and their regular work schedule, influenced the frequency of b-near usage during training sessions. Additionally, the distribution of the screens varied among individuals, potentially further delaying the b-near training sessions. During observations conducted in participants' homes, it was documented whether it was their first or second time using the b-near.

Additionally, interviews were conducted either after the second or third b-near training session. This distinction could potentially influence participants' proficiency with the device; however, neither significant issues nor concerns were observed or reported. This indicates that the b-near may possess intuitive usability, and the physiotherapists adeptly facilitated the training sessions. Although the timing of the b-near sessions may have influenced participants' statements, it is crucial to recognize that case studies, unlike controlled laboratory experiments, offer insights into real-world scenarios. They provide valuable opportunities to observe and analyze the practical application of technology, shedding light on factors affecting implementation [91].

During the preparation of the interview guide, knowledge was sought, and inspiration was drawn from NPT to address the research questions. Consequently, an interview guide was crafted to integrate both empirical data and theoretical insights. The theoretical orientation of the guide might have influenced the approach to gathering empirical data, potentially posing challenges to conceal preconceptions. However, it is essential to acknowledge Heidegger's perspective that complete concealment of preconceptions is impossible. Thus, the exact impact of the theoretical orientation on the phenomenological approach remains somewhat ambiguous. Nevertheless, the theory-driven nature of the guide may have led to questions that were overly focused on theoretical concepts, potentially limiting insight into the lifeworlds of the informants. As novice researchers, consideration was given to whether sufficient efforts were made to ask follow-up questions, ensuring avoidance of over-reliance on the interview guide. The heavy reliance on the guide may have unintentionally steered towards a more hermeneutic approach, potentially causing overlooking of important details about the participants' lifeworlds and relevant knowledge for the study.

Additionally, meticulous consideration was given to the Hawthorne effect within the scope of observations. This phenomenon arises when participants modify their behavior due to the awareness of being observed, potentially leading to altered or inflated behaviors [128]. Measures were taken to minimize participants' awareness of the observation process, thereby encouraging more natural behaviors during the observations.

7 Conclusion

This chapter synthesizes the project findings to address the problem statement and its underlying research questions:

What factors influence the future implementation of the b-near touch screen solution for patients following coronary artery bypass grafting from a patient perspective at Suðuroy Hospital in the Faroe Islands?

- What are the opportunities for implementation in the case?
- What are the barriers to implementation in the case?

This case study provides valuable insights into various factors influencing the future implementation of the b-near as an assistive tool for CABG patients at Suðuroy Hospital in the Faroe Islands. A unique aspect is that the Faroe Islands do not adhere to EU legislation on medical devices, allowing for the use of non-medical devices like the b-near for telerehabilitation at the hospital. This significantly enhances accessibility for CABG patients, potentially contributing to improved recovery and quality of life outcomes. Additionally, the predominantly publicly funded Faroese healthcare system, financed through taxation, addresses financial constraints such as reimbursement issues commonly faced by patients seeking access to healthcare technology globally.

Various opportunities and barriers for implementing the b-near was identified, drawing insights from participants within the case context. The themes mainly reflected reflexive monitoring work, aligning with the ongoing trials at Suðuroy Hospital. This study emphasizes the importance of incorporating insights gathered from the findings, as well as communal and individual appraisal work, into Suðuroy Hospital's considerations regarding adjustments to its future implementation strategy for the b-near system. While further research is encouraged to reevaluate the efficacy of the b-near for the telerehabilitation of CABG patients, the decision on whether to implement the system for CABG patients at present rests with Suðuroy Hospital. This decision must take into account various factors, including existing regulatory considerations, the limited research available, and the current barriers to implementation. As the implementation phase approaches, embracing the NPT as a valuable framework can facilitate the process. Normalizing the use of the b-near in clinical practice for CABG patients may necessitate a gradual transition, potentially spanning several years. Overcoming identified barriers is crucial for successful implementation, given the opportunities presented by the b-near in enhancing CABG patient care.

8 Perspective

In this chapter, the project will be taken into perspective in regard to future considerations for the implementation of telerehabilitation for CABG patients in Denmark.

In 2022, the Danish government introduced a digitalization strategy, investing over 2 billion DKK over five years to position Denmark as a global leader in healthcare technology. This strategy aims to provide better, more flexible, and personalized high-quality healthcare for citizens, businesses, and society, regardless of location. It includes expanding telemedical solutions like virtual consultations, home measurements, and patient-reported information [129]. In November 2023, the government emphasized the importance of digital solutions to address healthcare challenges, focusing on workforce shortages and the rising prevalence of chronic diseases. The strategy calls for increased investment in digital communication among municipalities, primary care sectors, and hospitals to ensure smooth transmission of relevant health information. Digital solutions for home treatment can streamline the delivery of flexible healthcare options, particularly for patients with chronic conditions, such as CAD [130].

While the implementation of b-near in hospital care for CABG patients may face regulatory challenges, its integration into phases 2 and 3 of rehabilitation in the primary care sector and municipalities could prove more feasible. Not all assistive devices require a CE mark as medical devices for use in municipalities or the primary sector [131]. In Denmark, phase 2 CR is provided post-discharge, involving collaboration between hospital settings and municipal sectors, with regional entities and municipalities responsible for providing recommended services [132]. Further investigation through larger studies on the feasibility of the b-near for telerehabilitation is essential to confirm its efficacy for implementation in municipalities. This case study from the Faroe Islands could serve as a foundational exploration, offering insights into its potential application, particularly within a Danish context. Given Denmark's digitalization strategy, an rapidly aging population [133] and the overall rise of CVD prevalence worldwide, innovative communication technologies like the b-near system appear well-positioned to shape the future landscape of the Danish healthcare system.

9 References

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