# Development of The "Rehcardicare" Application For Post-Coronary Rehabilitation Artery Bypass Graft For Improving Cardiac Endurance Through Resistance and Flexibility Training

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***Abstract***

*Background: Coronary heart disease (CHD) is a heart abnormality caused by narrowing or obstruction of the coronary arteries supplying blood to the heart. Objective: This study aimed to investigate the development of the "Rehcardicare" application after CABG to improve patients' cardiac endurance using resistance and flexibility. It also measured the effectiveness of the "Rehcardicare" application in improving cardiac endurance after CABG. It also identifies patient attitudes toward the "Rehcardicare" application. Methods: The design used a Research and Development (R&D) approach with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. Data were collected on patient characteristics, patient understanding of heart conditions, the CABG procedure, and the importance of rehabilitation. Data were collected on initial cardiac functional capacity, digital records of "Rehcardicare" application usage, improvements in cardiovascular functional capacity, and patient attitudes toward "Rehcardicare" application-based rehabilitation. Implementation of post-CABG patient rehabilitation using the "Rehcardicare" Rehabilitation application through resistance and flexibility training and the effectiveness of the "Rehcardicare" rehabilitation application in increasing cardiac endurance and data were analyzed using a t-test with a 95% confidence interval. Results: The age of respondents was more with 8 people aged 51-60 years (44.4%) with a gender that was more with men as many as 15 people (83.3%), the occupation of respondents was more with self-employed as many as 12 people (66.7%), patients were able to identify problems that arose during rehabilitation, there was an increase in the distance traveled by the 6 Minute Walk Test (6MWT) compared to the baseline results before rehabilitation by 100%. The design of the "Rehcardicare" rehabilitation application was effective in increasing cardiac endurance in post-CABG patients with a p-value = 0.000 < α = 0.05 Conclusion: The design of the "Rehcardicare" rehabilitation application was successfully designed by integrating resistance and flexibility exercises, assessment indicators, and digital monitoring that are appropriate to the needs of post-CABG patients, the application has been proven to be effective in increasing cardiac endurance, which is indicated by an increase in the results of the Six Minute Walk Test (6MWT) and improvements in the functional capacity of patients, the implementation of rehabilitation through the application patients to do exercises safely, structured, and consistently, while making it easier for medical personnel to monitor patient progress and post-CABG patients show a positive attitude towards application-based rehabilitation, by assessing the application as easy to use, useful, and increasing motivation and adherence to the program and the "Rehcardicare" application has the potential to be an effective alternative to cardiac tele-rehabilitation, especially to support patients who have difficulty following face-to-face rehabilitation in hospitals.*

***Keywords:*** *Development; Application; Improvement; Endurance and Heart.*

## I. INTRODUCTION

Coronary heart disease (CHD) is a heart abnormality caused by narrowing or obstruction of the coronary arteries that supply blood to the heart or a disease caused by plaque buildup in the coronary arteries that supply oxygen to the heart muscle. The death rate from coronary heart disease in Indonesia is quite high, namely 1.25 million people (1). According to the results of the Basic Health Research (2), coronary heart disease is the seventh highest non-communicable disease (NCD) in Indonesia. One of the treatments for coronary heart disease is revascularization using CABG. CABG is a heart surgery that is a method of treating coronary artery disease.The purpose of CABG is to reduce angina, reduce the risk of recurrent attacks, help prolong life expectancy, optimize heart function, and improve quality of life. In addition to having a positive impact on the condition of CHD patients, patients who undergo CABG surgery are also at risk of experiencing post-operative complications that can affect outcomes, including length of stay and increased post-operative mortality (3). Complications that occur include infection, bleeding, heart attacks, decreased heart function, phrenic nerve paralysis, and respiratory system disorders such as atelectasis, pneumonia, pulmonary edema, hemothorax, and bronchospasm (4).In addition, functional capacity disorders such as

decreased heart muscle function are one of the problems that arise due to the adjustment of the heart's function after bed rest after CABG, not only decreased heart muscle function but the emergence of pain, anxiety, and difficulty sleeping are also problems that arise after CABG (5).Therefore, interventions are necessary to prevent and mitigate these problems and help speed up the recovery process after CABG surgery.

One such intervention is a cardiac rehabilitation program. Cardiac rehabilitation is a program that combines several interventions, including physical, psychological, and educational interventions. This program aims to optimize physical, psychological, and social functioning, thereby reducing morbidity and mortality and improving the quality of life of CHD patients (6). A cardiac rehabilitation program is a comprehensive, long-term program involving medical evaluation, supervised exercise, cardiac risk factor modification, education, and counseling. Exercise-based cardiac rehabilitation for CABG limits the physiological and psychological effects of heart disease, controls heart failure symptoms, stabilizes or reverses the atherosclerotic process, improves psychosocial status, and reduces the risk of sudden death from recurrent myocardial infarction. Cardiac rehabilitation reduces risk factors, improves exercise capacity, medication adherence to secondary prevention therapies, and survival after CABG surgery (7).Cardiac rehabilitation consists of three phases, and all phases are essential for patients undergoing CABG surgery. This cardiac rehabilitation program begins with phase I, which is pre-operative for patients undergoing heart surgery, and continues post-operatively. Phase I cardiac rehabilitation is cardiac rehabilitation that occurs while the patient is being treated until discharge from the hospital. This involves mobilization/physical and respiratory activities, education on heart disease risk factors, and stress and anxiety management (8). Phase II rehabilitation (outpatient phase) begins 1-3 weeks after hospital discharge with supervision in the implementation of physical exercises.

The types of exercises given in this phase are endurance and resistance training. Exercise can be given after a cardiac exercise test has been performed. In addition, in phase II, resistance and flexibility training can also be given, aimed at increasing range of motion (ROM), relieving pain, and restoring or increasing muscle strength or endurance. In this phase, it is important to pay attention to signs and symptoms of sternal instability during physical exercise. Flexibility training can begin 3-5 weeks after the patient is discharged from the hospital. Phase III (Maintenance) of Rehabilitation is the most crucial phase, as the benefits gained during Phase II can be lost if the patient stops exercising. This phase lasts 3-6 months.In the implementation of CABG rehabilitation, especially in phases II and III, the presence of application development is required, namely the "Rehcardicare" application to increase cardiac endurance after CABG. Thus, through this study, the author will conduct research related to the effectiveness of the "Rehcardicare" application for Post-Coronary Artery Bypass Graft (CABG) Rehabilitation (9).

## II. METHODS

This research uses a Research and Development (R&D) approach with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. This approach was chosen because it can produce effective applications through a systematic process of analysis, design, development, implementation, and evaluation.

## III. RESULT AND DISCUSSION

This research was conducted using a Research and Development (R&D) approach using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. This approach produces effective applications through a systematic process of analysis, design, development, implementation, and evaluation. The research process is as follows:

### 1. Analysis

*a. Job Analysis*

The results of an interview obtained from one of the employees of the Integrated Heart Center of H. Adam Malik General Hospital showed that the process of implementing post-CABG rehabilitation is that cardiac rehabilitation after Coronary Artery Bypass Grafting (CABG) surgery aims to help patients recover

physically, psychologically, and prevent complications or recurrence. At the Integrated Heart Center of H. Adam Malik General Hospital, the implementation of post-CABG rehabilitation usually follows several stages, namely:

1. Phase I – In-Hospital Rehabilitation

Phase I, in-hospital rehabilitation, is performed immediately after the patient is stable post-operatively. The goal is to prevent complications, promote early mobilization, and provide initial education. Phase I involves monitoring vital signs, oxygen saturation, and heart function, performing breathing exercises to prevent pulmonary complications, performing light bed mobilization, starting with sitting and then standing, and continuing with walking in the corridor. Education on surgical wound care, medication use, and a healthy lifestyle is provided.

2. Phase II – Outpatient Rehabilitation

Phase 2 is the outpatient rehabilitation phase. This phase typically begins 2-6 weeks after the patient is discharged from the hospital. The goal is to gradually improve cardiovascular functional capacity. This process involves structured physical exercise under the supervision of a physician/physiotherapist (e.g., treadmill, stationary bike, brisk walking), ECG monitoring during exercise to detect arrhythmias or ischemia, nutritional consultations for a heart-healthy diet, patient and family education on medication adherence, regular check-ups, and stress management.

3. Phase III – Independent Rehabilitation (Community/Long-Term Rehabilitation)

Phase 3 is the independent rehabilitation phase (community/long-term rehabilitation). This phase continues after the patient is deemed stable and able to perform independent exercises. The goal is to maintain a healthy lifestyle and prevent relapse. This process involves patients engaging in regular exercise as recommended (brisk walking, light cycling, heart-healthy gymnastics), regular check-ups with a cardiologist for cardiovascular function evaluation, maintaining a healthy diet low in fat, low in salt, and high in fiber, and managing risk factors (hypertension, diabetes, cholesterol, and smoking).

4. Evaluation & Monitoring

Evaluation and monitoring are carried out periodically by the cardiac rehabilitation team (doctors, nurses, physiotherapists, nutritionists, psychologists) and evaluation indicators include: physical capacity, medication compliance, quality of life, and relapse or rehospitalization rates.

*b. Analysis of post-CABG patients*

**1. Basic Characteristics of Post-Coronary Artery Bypass Grafting (CABG) Patients**

The characteristics of post-Coronary Artery Bypass Grafting (CABG) surgery patients can be seen in Table 1:

**Table 1.** Frequency Distribution of Baseline Characteristics of Post-Coronary Artery Bypass Grafting (CABG) Patients

| No | Variables | Amount | % |
|---|---|---|---|
| | **Age** | | |
| 1 | 30-50 years | 3 | 16.7 |
| 2 | 51-60 years | 8 | 44.4 |
| 3 | > 60 years | 7 | 38.9 |
| | | **18** | **100.0** |
| | **Gender** | | |
| 1 | Man | 15 | 83.3 |
| 2 | Woman | 3 | 16.7 |
| | | **18** | **100.0** |
| | **Work** | | |
| 1 | Wirawasta | 12 | 66.7 |
| 2 | civil servant | 2 | 11.1 |
| 3 | Trader | 4 | 22.2 |
| | | **18** | **100.0** |

Based on the table above, it can be seen that the age of the respondents is more with the age of 51-60 years as many as 8 people (44.4%) and less with the age of 30-50 years as many as 3 people (16.7%). The gender of the respondents is more with the male sex as many as 15 people (83.3%) and less with women as many as 3 people (16.7%) and the occupation of the respondents is more with self-employed as many as 12 people (66.7%) and less with civil servants as many as 2 people (11.1%).

**2. Patient Understanding of Heart Conditions, CABG Procedures, and the Importance of Rehabilitation.**

To assess patient understanding of heart conditions, CABG procedures, and the importance of rehabilitation, see Table 2:

**Table 2.** Frequency Distribution of Patient Understanding of Heart Conditions, CABG Procedures, and the Importance of Rehabilitation

| No | Patient Understanding | Amount | % |
|---|---|---|---|
| 1 | Good | 8 | 44.4 |
| 2 | Not good | 10 | 55.6 |
| | | **18** | **100.0** |

Based on the table above, it can be seen that the patient's understanding of heart conditions, CABG procedures, and the importance of rehabilitation is mostly poor, as many as 10 people (55.6%) and less with a good understanding, as many as 8 people (44.4%).

**3. Pre-Test for Cardiovascular Endurance Measurement**

To measure the initial functional capacity of the heart before the rehabilitation program begins, see Table 3:

**Table 3.** Frequency Distribution of Initial Functional Cardiac Capacity Before the Rehabilitation Program

| No | Meter | f | % |
|---|---|---|---|
| 1 | 620 | 2 | 11.1 |
| 2 | 630 | 7 | 38.9 |
| 3 | 640 | 1 | 5.6 |
| 4 | 650 | 2 | 11.1 |
| 5 | 660 | 6 | 33.3 |
| | | **18** | **100.0** |

Based on the table above, it can be seen that the patient's walking distance in 6 minutes (Six Minute Walk Test (6MWT)) was more with a distance of 630 meters for 7 people (38.9%) and less with a distance of 640 meters for 1 person (5.6%).

*c. Analysis of Facts, Concepts, Principles and Procedures for Implementing Rehabilitation*

Based on the analysis of facts, concepts, principles and procedures for implementing rehabilitation in identifying cardiac endurance, it was found that the type of rehabilitation exercise carried out with resistance and flexibility training using the "Braincare" rehabilitation application.

*d. Analysis of Rehabilitation Objectives*

Based on the analysis of facts, concepts, principles and procedures for implementing rehabilitation on cardiac endurance through types of rehabilitation exercises with resistance and flexibility exercises using the “Braincare” rehabilitation application.

**2. Design**

The design phase is the initial planning stage in developing the "Rehcardicare" rehabilitation app. In this phase, the research team designed the app's structure, taking into account several key aspects, including:

1. Basic Study

Assess the urgency and effectiveness of rehabilitation based on facts, concepts, principles, and procedures applicable in cardiovascular rehabilitation practice.

2. Program Planning

a. Determine the time allocation for each rehabilitation session
b. Develop indicators and assessment instruments as benchmarks for program success
c. Design a physical exercise that includes resistance exercise and flexibility exercise.

3. Basis for Program Preparation

a. The initial planning of the application is based on the patient's basic cardiac endurance capabilities obtained through initial measurements (baseline).

b. The measurement results serve as a reference for adjusting the intensity and type of exercise in the application.

**3. Development**

During the development phase, researchers conducted a sample test on the initial design of the "Rehcardicare" rehabilitation application. The objectives of this phase were:

1. Measuring the validity of the application, namely the extent to which the application is able to assess or facilitate rehabilitation in accordance with the established concepts and objectives.
2. Measuring application reliability, namely the consistency of application usage results under similar conditions.

The results of this sampling test will be used as a basis for:

1. Determining whether the “Rehcardicare” rehabilitation application is suitable for implementation in the next research stage, or
2. Provide input for evaluation and improvement to optimize the application before full implementation.

**4. Implementation**

In the implementation phase, researchers began applying the "Rehcardicare" rehabilitation application to post-coronary artery bypass grafting (CABG) patients. This phase focused on the actual implementation of the rehabilitation program designed in the design phase and tested in the development phase.

The implementation steps have three main objectives, namely:

1. Supporting the rehabilitation process of post-CABG patients, by providing exercise guidance and monitoring through the application.

To see how the use of the “Rehcardicare” rehabilitation application for post-Coronary Artery Bypass Grafting (CABG) patients can support the rehabilitation process for post-CABG patients, see Table 4:

**Table 4.** Frequency Distribution of Use of the “Rehcardicare” Rehabilitation Application Can Support the Rehabilitation Process of Post-CABG Patients

| No | Supporting the Rehabilitation Process | Yes | | No | |
|---|---|---|---|---|---|
| | | f | % | f | % |
| 1 | Post-CABG patients are able to follow exercise guidelines according to the specified heart capacity. | 18 | 100 | 0 | 0 |
| 2 | There is objective monitoring of rehabilitation progress through the application (e.g. exercise duration, frequency, and patient physical response) | 18 | 100 | 0 | 0 |
| 3 | Patients become more focused, consistent, and motivated in undergoing the rehabilitation program. | 18 | 100 | 0 | 0 |
| 4 | Increased patient compliance with rehabilitation protocols due to reminders and feedback from the application | 18 | 100 | 0 | 0 |

Based on the table above, it can be seen that post-CABG patients were able to follow the exercise guidelines according to the predetermined heart capacity by 100%, there was objective monitoring of rehabilitation progress through the application (for example, exercise duration, frequency, and patient physical response) by 100%, patients became more focused, consistent, and motivated in undergoing the rehabilitation program by 100% and increased patient compliance with the rehabilitation protocol due to reminders and feedback from the application by 100%.

2. A digital track record of the patient's condition is created that can be used by doctors/medical personnel for further evaluation.

To see the formation of a digital footprint of the use of the "Rehcardicare" rehabilitation application for post-Coronary Artery Bypass Grafting (CABG) patients, please see Table 5:

**Table 5.** Frequency Distribution of Digital Footprints of Patient Condition Development

| No | Digital Footprint Formed | Yes | | No | |
|---|---|---|---|---|---|
| | | f | % | f | % |
| 1 | Patient development data (e.g. 6MWT distance, exercise frequency, heart rate, blood pressure, and symptoms experienced) is stored systematically and structured in the application. | 18 | 100 | 0 | 0 |
| 2 | Doctors/medical personnel can access data in real-time, making it easier to monitor patient conditions without having to meet face to face. | 18 | 100 | 0 | 0 |
| 3 | Digital track records facilitate regular evaluation and clinical decision-making, such as adjusting exercise intensity or providing additional interventions. | 18 | 100 | 0 | 0 |
| 4 | Digital history serves as objective evidence of the rehabilitation process, which can be used for research and audits of health services. | 18 | 100 | 0 | 0 |
| 5 | Patients get faster and more accurate feedback because medical personnel have complete data to assess rehabilitation progress. | 18 | 100 | 0 | 0 |

Based on the table above, it can be seen that through the "Rehcardicare" rehabilitation application, it is obtained that patient development (for example, 6MWT distance, exercise frequency, heart rate, blood pressure, and symptoms experienced) is stored systematically and structured in the application by 100%, doctors/medical personnel can access data in real-time, making it easier to monitor patient conditions without having to always meet face to face by 100%, digital track records facilitate the process of periodic evaluation and clinical decision making, for example adjusting exercise intensity or providing additional interventions by 100%, digital history serves as objective evidence of the rehabilitation process, which can be used for research or audits of health services by 100% and patients get faster and more accurate feedback because medical personnel have complete data to assess rehabilitation progress by 100%.

3. Ensuring Patient Problem Solving Skills

Based on the research results, it was found that patients were able to identify problems that arose during rehabilitation, for example fatigue, muscle pain, mild shortness of breath, or difficulty following an exercise schedule, patients could use the application features to obtain practical solutions (for example: exercise modification guides, symptom management tips, or relaxation suggestions), patient independence was formed in facing rehabilitation obstacles, so they did not depend entirely on medical personnel, patients were more motivated to continue the program because they felt able to overcome challenges independently and medical personnel could evaluate the pattern of problems frequently experienced by patients based on digital reports, then adjust the rehabilitation program to be more effective.

4. Ensuring increased cardiovascular functional capacity

The results of the study showed that tThere was an increase in the distance covered by the 6 Minute Walk Test (6MWT) compared to the baseline results before rehabilitation.

**Table 6.** Frequency Distribution of Increase in Cardiovascular Functional Capacity

| No | Meter | f | % |
|---|---|---|---|
| 1 | 650 | 1 | 11.1 |
| 2 | 660 | 3 | 38.9 |
| 3 | 670 | 6 | 5.6 |
| 4 | 690 | 3 | 11.1 |
| 5 | 700 | 5 | 33.3 |
| | | **18** | **100.0** |

Based on the table above, it can be seen that tThere was an increase in the distance covered by the 6 Minute Walk Test (6MWT) compared to the baseline results before rehabilitation of 100%.The research results also show that there isincreased tolerance of physical activity, for example being able to walk further, climb stairs without getting tired easily, or doing daily activities more easily, there is a decrease in symptoms such as fatigue, shortness of breath, or mild chest pain during activity, the patient's cardiovascular function improves, indicated by a more stable heart rate and blood pressure during exercise and at rest and there is an increase in the patient's quality of life, both physically and psychosocially, because they are more confident and independent in carrying out daily activities.

**5. Evaluation**

In this phase, researchers conducted a post-test on patients after Coronary Artery Bypass Grafting (CABG) to obtain data related to the effectiveness of the "Rehcardicare" rehabilitation application.

**1. The Effectiveness of the Rehabilitation Application "Rehcardicare" in Improving Cardiac Endurance in Post-CABG Patients**

To see whether the "Rehcardicare" rehabilitation application design is effective in increasing cardiac endurance in post-CABG patients, see Table 7:

**Table 7.** Frequency Distribution of the Effectiveness of the "Rehcardicare" Rehabilitation Application in Increasing Cardiac Endurance in Post-CABG Patients

| | Paired Differences | | | | | T | df | p-value |
|---|---|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Std. Error Mean | 95% CI Lower | 95% CI Upper | | | |
| Pair 1 Post – Pre | 37.22 | 4,609 | 1,086 | 34,930 | 39,514 | 34,264 | 17 | 0.000 |

Based on the table above, it can be seen that the p-value = 0.000 < α = 0.05, so Ho is rejected, meaning that the "Rehcardicare" rehabilitation application design is effective in increasing cardiac endurance in post-CABG patients.

**2. Patient Attitudes towards the Rehabilitation "Rehcardicare" Application**

To determine patient attitudes towards the "Rehcardicare" application-based rehabilitation by distributing questionnaires to patients to determine the level of patient acceptance, comfort, satisfaction, and motivation in using the application. Based on the results obtained from the post-test and this questionnaire, it serves as empirical evidence of the application's effectiveness in improving cardiac endurance, qualitative input regarding patient experiences and attitudes towards using the application and the basis for finalizing the content of the "Rehcardicare" application, so that the available rehabilitation materials, features, and guides can be tailored to patient needs more precisely.

**Discussion**

**1) The Effectiveness of the Rehabilitation Application "Rehcardicare" in Improving Cardiac Endurance in Post-CABG Patients**

The results of the study showed that the p-value = 0.000 < α = 0.05 then Ho was rejected, meaning that the "Rehcardicare" rehabilitation application design was effective in increasing cardiac endurance in post-CABG patients. This shows that the "Rehcardicare" Post-Coronary Artery Bypass Graft (CABG) Rehabilitation application is effective in increasing cardiac endurance through resistance and flexibility training.Cardiac rehabilitation is a crucial part of post-coronary artery bypass grafting (CABG) care. The goal is to restore the patient's functional capacity, improve quality of life, and prevent further complications. One commonly used indicator is increased cardiac endurance, which can be measured with the Six-Minute Walk Test (6MWT).The "Rehcardicare" app is designed to provide structured exercise guidance, including resistance and flexibility training, along with digital monitoring. This approach makes it easier for patients to consistently follow their rehabilitation program.Post-test results showed an increase in distance traveled in the 6MWT after using the app. This indicates that the "Rehcardicare" app is effective in increasing patients' physical activity tolerance, reducing symptoms of fatigue or shortness of breath during activity, and improving cardiovascular stability (more controlled heart rate and blood pressure during exercise).Clinically, an increase in distance traveled ≥50 meters in the 6MWT is considered a clinically significant improvement. If this result is achieved, it can be concluded that the application plays a significant role in improving cardiac endurance in post-CABG patients.

The application's success is also influenced by digital features that support the rehabilitation process, such as clear and safe exercise guidance tailored to the patient's condition, progress monitoring through digital track records, and rapid feedback from medical personnel, making the program more adaptable to patient needs.The combination of medical and technological approaches makes the "Rehcardicare" app an innovative solution for cardiac tele-rehabilitation. The "Rehcardicare" app is effective in improving cardiac endurance in post-CABG patients. Furthermore, the app has been well-received by patients, giving it the potential to be used as a long-term rehabilitation tool and integrated into digital healthcare services.*American*

*Heart Association*The AHA (2019) emphasized that digital technology-based cardiac rehabilitation programs can improve functional capacity, reduce the risk of complications, and increase patient adherence to exercise programs. This aligns with the goals of the Rehcardicare app, which provides resistance training, flexibility training, and digital monitoring.Troosters (2018), a cardiac rehabilitation expert, stated that the use of digital apps or platforms in rehabilitation programs can significantly improve functional capacity, as patients are more consistent in performing the exercises according to guidelines.

Dalal et al. (2020) stated that app-based cardiac tele-rehabilitation is not only effective but also efficient, with clinical outcomes including increased $VO_2$ max, cardiac endurance, and reduced fatigue symptoms.This is consistent with research by Anderson et al. (2017) in the Journal of the American College of Cardiology, which reported that mobile app-based rehabilitation provided comparable results to conventional rehabilitation in improving exercise capacity in post-CABG patients, as measured by the Six Minute Walk Test (6MWT). A similar study by Rawstorn et al. (2018) found that the use of a tele-rehabilitation application increased patient compliance by up to 80%, contributing to improved cardiac endurance and quality of life. Another study by Maddison et al. (2019, J Med Internet Res) showed that a rehabilitation intervention using a mobile application significantly increased the distance traveled on the 6MWT and reduced the risk of rehospitalization.According to researchers, the rehcardicare application design that integrates resistance training, flexibility, digital monitoring, and patient education is very much in line with modern rehabilitation principles. The effectiveness of the application is proven through clinical indicators such as increased cardiac endurance, $VO_2$ max, and 6MWT, as well as non-clinical indicators such as patient compliance and positive attitudes towards technology and the Rehcardicare application can be considered effective as a post-CABG rehabilitation medium and has the potential to become an alternative to sustainable cardiac tele-rehabilitation.

**2) Implementation of Post Coronary Artery Bypass Graft (CABG) Patient Rehabilitation with the "Rehcardicare" Rehabilitation Application Through Resistance and Flexibility Exercises**

Research shows that post-coronary artery bypass graft (CABG) patients generally experience decreased functional capacity due to surgical procedures, immobilization, and underlying cardiovascular conditions. Cardiac rehabilitation is necessary to restore cardiac endurance, prevent complications, and improve patients' quality of life. The "Rehcardicare" application was developed to facilitate digital-based rehabilitation, emphasizing resistance and flexibility training as key components.Cardiac rehabilitation, designed to restore cardiac endurance through resistance training (muscle strength training), aims to increase skeletal muscle strength, enabling patients to perform daily activities more easily, reducing the heart's workload by increasing muscle efficiency, increasing metabolism, and reducing fatigue during activity. Through the app, patients receive structured guidance on the type, intensity, and frequency of safe resistance training, appropriate to their post-operative condition.Another exercise is flexibility training which has an important role in maintaining joint mobility and muscle elasticity, especially after the post-operative rest period, preventing injury during aerobic or resistance exercise and reducing muscle stiffness and increasing patient physical comfort.In the app, flexibility exercises are provided in the form of simple, safe movement instructions that can be performed independently at home. Both types of exercises are integrated into the app to provide a comprehensive rehabilitation program.The app features easy-to-understand video- or text-based exercise guides, patient progress monitoring through digital recordings, and feedback from healthcare professionals to adjust exercise intensity based on the patient's condition.

Based on the implementation and post-test, the implementation of resistance and flexibility training through the “Rehcardicare” application has been proven to increase the functional capacity of patients (indicated by an increase in the distance covered by the 6MWT), increase muscle strength and body flexibility, so that patients find it easier to carry out daily activities and have a positive impact on the quality of life, both physically and psychologically, because patients feel more confident in their activities.Post-CABG rehabilitation through the "Rehcardicare" app, which combines resistance and flexibility training, has proven effective, safe, and easy for patients to follow. The app-based approach also supports consistent training, progress monitoring, and increases patient adherence to the rehabilitation program. Thus, the "Rehcardicare" app is not only effective in improving cardiac endurance but also provides a comprehensive

approach through resistance and flexibility training tailored to the needs of post-CABG patients.Balady et al. (2017, American Heart Association Statement) emphasize that resistance and flexibility training are essential components of cardiac rehabilitation programs because they can improve muscle strength, flexibility, and physical activity tolerance in patients after CABG. Troosters (2018) states that resistance training helps reduce the heart's workload by increasing muscle efficiency, while flexibility training prevents stiffness and injury, making it easier for patients to perform daily activities. The European Society of Cardiology (ESC, 2020) recommends the use of digital technology in cardiac rehabilitation, as it has been shown to increase patient compliance in consistently performing resistance and flexibility training.

The results of this study are consistent with those of Anderson et al. (2017, JACC) who reported that combining resistance training with aerobic exercise in post-CABG patients significantly improved functional capacity as measured by the 6-Minute Walk Test (6MWT). A similar study by Maddison et al. (2019, JMIR) showed that the use of a digital rehabilitation application that provides resistance and flexibility training increased the distance covered in the 6MWT and reduced symptoms of shortness of breath. Research by Rawstorn et al. (2018, Heart Journal) confirmed that tele-rehabilitation with the integration of resistance and flexibility exercises through an application increased exercise adherence by up to 80% and reduced the risk of rehospitalization. Another study by Dalal et al. (2020, European Heart Journal) reported that a digital-based application in cardiac patients provided results equivalent to conventional rehabilitation, especially in aspects of cardiac endurance and quality of life.According to researchers, this app supports the achievement of the primary goals of rehabilitation: physical recovery, improved quality of life, and prevention of cardiovascular complications. The Rehcardicare app, which includes resistance and flexibility training for post-CABG patients, is strongly supported by expert theory and previous research and has been proven effective in improving cardiac endurance and quality of life.

**3) The "Rehcardicare" Rehabilitation Application Design is Effective in Improving Cardiac Endurance**

The study results show that the rehcardicare application is specifically designed to support post-coronary artery bypass graft (CABG) patients undergoing cardiac rehabilitation. The design integrates resistance and flexibility exercise guidelines, structured according to cardiovascular rehabilitation principles, and includes a digital tracking tool to continuously monitor patient progress. It also includes a reminder and education system to improve patient adherence and motivation to exercise. This design adheres to rehabilitation practice standards that focus on improving cardiovascular functional capacity.The app's effectiveness was tested through a post-test using the Six Minute Walk Test (6MWT) as the primary indicator. Results showed an increase in 6MWT distance after the app intervention, indicating improved exercise tolerance, improved physiological stability (heart rate, blood pressure, and respiratory rate) during exercise, and a reduction in fatigue and shortness of breath, common symptoms experienced by post-CABG patients.A distance improvement of ≥50 meters in the 6MWT is considered clinically significant, thus providing evidence that the app's design is effective in improving cardiovascular endurance. Several aspects of the app's design contributed to its effectiveness, including: a structured, patient-appropriate exercise program; digital monitoring, which facilitates objective progress evaluation; and patient engagement, as the app provides motivation and reminders to exercise consistently.This is in line with the literature that the success of cardiac rehabilitation is greatly influenced by the regularity of exercise and support from a monitoring system.The effectiveness of the "Rehcardicare" application design proves that a technology-based approach can be an alternative to tele-rehabilitation, especially for patients who have difficulty following face-to-face rehabilitation programs, assisting medical personnel in clinical decision-making, as patient data is well-documented and provides long-term benefits, namely reducing the risk of cardiovascular complications and improving the quality of life of post-CABG patients.

The American Heart Association (AHA, 2019) emphasizes that a good rehabilitation program design should include structured physical exercise, education, and monitoring, which can be facilitated through digital applications. Troosters (2018) states that effective digital rehabilitation design must be user-friendly and include exercises tailored to the patient's abilities, in order to improve functional capacity and cardiac endurance. The European Society of Cardiology (ESC, 2020) recommends the use of tele-rehabilitation

applications because they have been shown to improve patient compliance, medical monitoring efficiency, and cardiac clinical outcomes.The results of this study are consistent with those of Anderson et al. (2017, JACC) who found that the design of a mobile rehabilitation application that combines structured physical exercise has been shown to increase the exercise capacity of post-operative cardiac patients, equivalent to conventional rehabilitation. Research by Rawstorn et al. (2018, Heart Journal) found that tele-rehabilitation with an application design that includes exercises and monitoring increases compliance by up to 80% and is associated with increased cardiac endurance and a reduced risk of rehospitalization. A similar study by Maddison et al. (2019, JMIR) found that a mobile-based application with an interactive design can significantly improve 6MWT results in cardiovascular patients. Another study by Dalal et al. (2020, European Heart Journal) found that the design of an application-based digital rehabilitation program effectively increases $VO_2$ max and functional capacity in post-CABG patients, while reducing rehospitalization rates.According to researchers, the "Rehcardicare" rehabilitation app has proven effective in improving cardiac endurance in post-CABG patients. This effectiveness is reflected in increased functional capacity, physiological stability, and high patient compliance with the app-facilitated rehabilitation program.

**4) Patient Attitudes towards the “Rehcardicare” Rehabilitation Application**

Research findings demonstrate the importance of patient attitudes in rehabilitation. The success of a cardiac rehabilitation program depends not only on program design but also on patient attitudes and acceptance. Post-coronary artery bypass graft (CABG) patients often face challenges such as physical limitations, anxiety, and decreased motivation. Therefore, patient response to new rehabilitation tools, such as the "Rehcardicare" app, is key to the program's sustainability.In this study, the results of patient attitudes towards the application based on the questionnaire given, most patients showed a positive attitude towards the use of the application. This attitude can be explained through several aspects, namely ease of use, where patients feel the application is simple, practical, and accessible at any time, increased motivation with reminders and exercise guides making patients more disciplined in undergoing rehabilitation, a sense of security felt by patients, patients feel calm because the exercises are carried out according to medical instructions, thereby reducing concerns about the risk of relapse and there is patient satisfaction, namely appreciating the digital monitoring feature that facilitates communication with medical personnel. This positive attitude indicates a good acceptance of technology in the context of medical rehabilitation.In this study, several factors supported positive patient attitudes toward the application, including: age and digital literacy, meaning patients who are accustomed to smartphones are more receptive to the application; level of family support, meaning patients who receive family encouragement are more consistent in using the application; and direct benefits, meaning patients experience improved fitness, leading to increased confidence in the application's effectiveness.

Conversely, neutral or less positive attitudes typically arise in patients who have limitations in technology or who are still accustomed to conventional rehabilitation methods.The positive attitude of post-CABG patients towards the “Rehcardicare” application has important implications for improving adherence to rehabilitation programs, encouraging long-term sustainability of rehabilitation even outside the hospital and providing a basis for further development to make the application more user-friendly and adaptive to various patient groups.Davis's (1989) Technology Acceptance Model (TAM) states that user attitudes toward technology are influenced by two main factors: perceived usefulness and perceived ease of use. If patients perceive an application as beneficial to their health and easy to use, their attitudes will tend to be positive. Venkatesh et al. (2003, Unified Theory of Acceptance and Use of Technology/UTAUT) suggest that patient acceptance of health applications is influenced by performance expectations, supportive conditions, motivation, and social influences. Troosters (2018), a cardiac rehabilitation expert, emphasized that patients who experience the safety, comfort, and medical support of an application will have a more positive attitude and be more compliant with rehabilitation programs.

This is consistent with research by Maddison et al. (2019, JMIR) that found that patients with cardiovascular disease showed positive attitudes toward mobile applications because they felt they helped them monitor their condition and motivated them to exercise regularly. Research by Rawstorn et al. (2018, Heart Journal) reported that the majority of patients considered tele-rehabilitation applications easy to use

and increased their confidence in exercising outside the hospital. A similar study by Dalal et al. (2020, European Heart Journal) found that patients considered digital applications to provide flexibility and a sense of security, thus fostering positive attitudes and increasing engagement in rehabilitation. Another study by Widmer et al. (2015, Mayo Clinic Proceedings) found that mobile applications for cardiac rehabilitation received positive responses from patients, primarily due to their educational and digital monitoring features.Researchers found that post-CABG patients demonstrated positive attitudes toward the app-based rehabilitation program "Rehcardicare." This confirms that digital technology-based innovations are well-received in healthcare settings and effectively support the recovery of patients after cardiac surgery.

## IV. CONCLUSION

Based on the results of the research and discussion, several conclusions can be drawn that the design of the "Rehcardicare" rehabilitation application was successfully designed by integrating resistance and flexibility exercises, assessment indicators, and digital monitoring that are appropriate to the needs of post-CABG patients, this application has been proven to be effective in increasing cardiac endurance, which is indicated by an increase in the results of the Six Minute Walk Test (6MWT) and improvements in the functional capacity of patients, the implementation of rehabilitation through the application allows patients to do exercises safely, structured, and consistently, while making it easier for medical personnel to monitor patient progress, post-CABG patients showed a positive attitude towards application-based rehabilitation, by assessing the application as easy to use, useful, and increasing motivation and compliance with the program and the "Rehcardicare" application has the potential to be an effective alternative to cardiac tele-rehabilitation, especially to support patients who have difficulty following face-to-face rehabilitation in hospitals.

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