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SYSTEMATIC REVIEW

LITERATURE REVIEW: EFFECTIVENESS OF CARDIAC REHABILITATION IN PATIENTS WITH CORONARY HEART DISEASE

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ABSTRACT

Background: Cardiac rehabilitation is an evidence-based intervention that includes physical exercise, health education, and modification of health behavior in patients with cardiovascular disease. Cardiac rehabilitation is a secondary prevention after acute coronary syndrome and improves treatment outcomes in patients with coronary heart disease. This literature review aimed to evaluate the effectiveness of cardiac rehabilitation in coronary heart disease patients. **Methods**: This present study was a literature review discussing cardiac rehabilitation for coronary heart disease patients. **Results:** The result showed that the functional capacity of the CR group was more increased compared to non-CR ($p < 0.001$; $\alpha < 0.05$), left ventricular ejection fraction was significantly increased in the CR group ($p < 0.05$; $\alpha < 0.05$), the medical cost of CR group was lower significantly ($p=0.042$; $\alpha < 0.05$), the risk of recurrence rate was significantly lower in CR group ($p=0.004$; $\alpha < 0.05$), and QoL of CR group was higher significantly ($p=0.001$; $\alpha < 0.05$). **Conclusions:** Cardiac rehabilitation is known to increase functional capacity, increase left ventricular ejection fraction (LVEF), reduce medical costs, reduce the recurrence rate, and increase QoL of patients with CHD.

Keywords

Coronary Heart Disease, Cardiac Rehabilitation

INTRODUCTION

Cardiovascular disease (CVD) is a common cause of health care problems and socio-economic globally. The impact of CHD is morbidity, disability by 10%, and mortality by 30% in the world caused by CVD. So far, Coronary Heart Disease (CHD) is the leading cause of death for CVD patients worldwide (Q. Zhang, 2019). CHD is closely related to coronary arteries that function to supply oxygenated blood for heart muscle metabolism. In CHD conditions, atherosclerotic plaque develops inside the coronary arteries resulting in arterial stenosis. Stenosis and reduced blood supply to the coronary arteries can cause dangerous effects on the heart muscle and can cause myocardial infarction (Themistocleous, Stefanakis, & Douda, 2017).

Risk factors that cannot be changed in patients with CHD include age, sex, and heredity (Themistocleous et al., 2017). Risk factors that can be changed based on the results of the study show that BMI 27.1 kg/m^2 with a standard deviation of 4.2 kg/m^2, hypertension by 67.1%, dyslipidemia by 62.1%, diabetes mellitus by 32.7%, and smoking habits by 30.3% (Viana et al., 2018). Although modifiable CHD risk factors contribute simply to the prognosis of the disease, the results of the

study indicate that controlling or eliminating these risk factors can reduce substantially in the total CHD incidence (Pencina et al., 2019).

Cardiac rehabilitation (CR) is considered as a foundation in secondary prevention after acute coronary syndrome and improves outcomes in CHD. CR has been shown to reduce cardiovascular mortality and hospitalization and improve the physical function of CHD patients (Francis et al., 2019). CR is a multidisciplinary intervention that improves the physical, psychological, and social functions of patients. The heart rehabilitation program includes physical exercise and strategies to reduce modifiable risk factors such as diabetes mellitus, hyperlipidemia, hypertension, smoking habits, and increase adherence to pharmacological and non-pharmacological therapies (Aguiar et al., 2017).

Decreased activity in patients with CHD can cause to decrease in physical function and physical capacity of the patient. Multidisciplinary CR does not only focus on physical activity but is associated with modification of risk factors that can aggravate the prognosis of CHD. This literature review to determine the effectiveness of CR in coronary heart patient disease.

METHOD

This present study was a literature review discussing cardiac rehabilitation for coronary heart disease patients. Google Scholar, Pubmed, Proquest were chosen as the database. This study applied a Randomized Controlled Trial, Retrospective Chart Review, Literature View, Meta-analysis.

RESULT

Tabel 1 Review Article

Author	Aims	Method	Result
Marita, Ina., Sastradimaja, Sunaryo B., Tiksnadi (2013)	To evaluate the effect of a short-term CR program on quality of life in patients with coronary artery disease.	Method: Quasi-Experimental Study used repeated measurements in consecutive sampling Sample: 11 patients with CAD without a control group Intervention: Before being given the CR program, the respondents measured their vital signs and performed a submaximal exercise test to determine their basic training capacity using a 6-minute walking test (6 MWT). Respondents were given aerobic exercise modalities using a treadmill (under the supervision of a doctor) in the hospital, and walking at home 3-5 times per week (in the hospital 2 times and at home 3 times). The duration of the exercise modality was ≥30 minutes, consisting of warm-up (≥5 minutes), aerobic exercise (≥20 minutes), and cool-down (≥5 minutes). Intensity exercise in the hospital was 70-85% of the maximum HR and 60-70% of the VO2 max, while 60-75% of	The results showed that the mean of physical health component before the intervention was 43.04 with a standard deviation of 5.7, while the mean of physical health component after the intervention was 87.16 with a standard deviation of 10.9. The results of the further analysis showed that there was a significant difference between the physical health component before and after the intervention ($p = 0.001$; $\alpha < 0.05$). The mean of mental health component before the intervention was 63.93 with a standard deviation of 15.4, while the mean of mental health component after the intervention was 87.29 with a standard deviation of 8.8. The results of the further analysis showed that there was a significant difference between the mental health component before and after the intervention ($p = 0.001$; $\alpha < 0.05$). The mean of QoL before the intervention was 49.09 with a standard deviation of 8.4, while the mean of QoL after the intervention was 87.27 with a standard deviation of 8.5. The results of the further analysis showed that there was a significant difference between the

		the maximum HR was for home training. The intervention was given for 4 weeks, ie every visit to the respondent's hospital was given counseling related to risk factors, stress management, and health education.	QoL before and after the intervention ($p = 0.001$; $\alpha < 0.05$).
Chen, Liu, & Chen (2015)	Evaluate the medical costs and recurrence rate of acute myocardial infarction after cardiac rehabilitation	Method: Retrospective Study The total sample was 432 respondents. In this study was divided into 2 groups: 1st group (given cardiac rehabilitation, n = 43 respondents) and 2nd group (without cardiac rehabilitation, n = 389 respondents)	The result showed that 1st group had lower risk of acute myocardial infarction recurrence than 2nd group (HR 0.640; 95% CI 0.197-1.863; p = 0.004). The medical cost in 1st group was lower than in 2nd group (HR 0.947; 95% CI 0.934, 0.981; p = 0.042).
Rees, Martin, & Taylor, (2016)	Update the Cochrane systematic review and exercise-based rehabilitation meta-analysis for patients with coronary heart disease.	Method: Cochrane Central Register of CINAHL, Controlled Trials, MEDLINE, EMBASE, and Science Citation Index. Randomized controlled trials (RCTs) of at least sixth months of follow-up comparing cardiac rehabilitation with control groups after myocardial infarction or revascularization or with a diagnosis of angina pectoris or coronary heart disease determined by angiographic examination.	A total of 63 studies with 14,486 respondents. The results showed that mortality decreased with CR intervention (RR 0.74; 95% CI 0.64 to 0.86), readmission (RR 0.82; 95% CI 0.70 to 0.96)
(Bravo-Escobar et al (2017)	To analyze the safety and effectiveness and of a home-based CR program in ischemic cardiopathology patients at moderate cardiovascular risk	Method: Randomized Control Multicentre Clinical Trial Sample: 28 patients with stable coronary artery disease (CAD) at moderate cardiovascular risk (n =14 respondents with control group, n = 14 respondents with experimental group). Intervention: <u>Hospital CR</u> The exercises were given 3 times a week (24 sessions) and were recommended for home-based exercises based on the European Society of Cardiology guidelines. <u>Home-Based CR</u> 1) Respondents were given training in the cardiac rehabilitation unit once a week; 2) Respondents did the exercises at home monitored by a remote electrocardiographic monitoring device (NUUBO®); 3) Home-based exercise included walking at 70% of HR reserve (during 1st month) and 80% of HR reserve (during 2nd month) for 1 hour per day, carried out for 5-7 days per week.	The results showed that the mean QoL in the Hospital-based cardiac rehabilitation program group was 63.63 with a standard deviation of 21.00, while the mean in the Home-based cardiac rehabilitation program group was 43.62 with a standard deviation of 24.20. The analysis showed that there was a significant difference between the Hospital-based cardiac rehabilitation program and the Home-based cardiac rehabilitation program group ($p = 0.004$; $\alpha < 0.01$).
Intarakamhang & Intarakamhang (2013)(Lynggaard, Nielsen, Zwisler, Taylor, & May, 2017)	To determine the effect of a comprehensive CR program on psychological factors including self-regulation, self-efficacy, self-	Method: quasi-experimental research with a repeated one group design Sample: 80 patients with CAD from Surgical or Medicine at the Phramongkutklao Hospital Intervention: 1) Twice or more bedside	The results showed that after being given CR program intervention, most of the self-efficacy increased, namely 50.00%, self-regulation by 58.80%, self-care 46.20%, and QoL by 72.50%. However, most of the BMI did not experience a change of 70.00%. The analysis showed that there were

	care, quality of life, and body mass index.	training; 2) Counseling for patients and caregivers regarding simple diet control (low sugar, low salt, low fat, stress reduction) is recorded in a diet logbook; 3) health advice was given one week after the patient is discharged from the hospital; 4) Individual or group counseling at a cardiac rehabilitation clinic for 30-60 minutes, carried out 2 weeks after the patients were discharged from the hospital; 5) Evaluation was carried out based on the logbook related to exercise and diet and a post-test was carried out after 6 weeks of discharge from the hospital.	significant differences in self-efficacy ($p = 0.005$; $\alpha < 0.05$), self-regulation ($p = 0.000$; $\alpha < 0.05$), BMI ($p = 0.001$; $\alpha < 0.05$), and QoL ($p = 0.000$; $\alpha < 0.05$) before and after being given the CR program in patients with CAD.
Avila et al., (2018)	To find out the benefits of a home-based cardiac rehabilitation program with guidance on physical fitness telemonitoring in CAD patients who have completed a phase II CR program and to compare the effectiveness of a prolonged center-based CR program by randomized controlled trial	Method: Randomized Controlled Trial Sample: 84 patients with CAD were divided into 3 groups, such as home-based group (n=28 respondents), centre-based group (n=30 respondents), control group (n=26 respondents). Intervention: Home-Based Group Aerobic exercise was given 3 sessions for 150 min per week (6-7 days/week). The Target heart rate was 70-80% reserve during 12 weeks of intervention. Center-based Group Endurance training consisted of cycling (2x7 min), walking or treadmill (2x7 min), arm ergometry or rowing (7 min), dynamic calisthenics (2x7 min). Resistance training was given 3 sessions of 150 minutes per week. Endurance training consisted of cycling (2x7 minutes), walking or treadmill (2x7 minutes), arm or rowing ergometry (7 minutes), and dynamic exercise (2x7 minutes).	The results showed that there were significant differences between the home-based group, the center-based group, and the control group (group x time interaction, $p = 0.04$; $\alpha < 0.05$) with a greater increase in the home-based group ($p = 0{,}03$; $\alpha < 0.05$) and the center-based group ($p = 0.04$; $\alpha < 0.05$) were compared with the control group.
Vieira, Melo, Machado, & Gabriel (2018)	To determine the effectiveness of the home-based phase III CR specific exercise program for 6 months carried out conventionally (booklet) or virtual reality (Kinect) on quality of life and depression, anxiety and stress, and executive function.	Method: Randomized Controlled Trial Sample: 33 patients with coronary artery disease (CAD) were divided into 3 groups, namely 1st intervention group (IG1, n=11 respondents with home-based CR using a computer and Kinect), 2nd intervention group (IG2, n=11 respondents with home-based CR using a paper booklet), 3rd control group (CG, n=11 respondents with usual care) Intervention: 1st level was 65% of the heart rate reserve, 2nd level (3 months passed) was 70% heart rate reserve. Exercises were given 3 times a week for 6 months, in addition to the training	The study results showed that there were a significant increase in conflict resolution and selective attention in the IG1 group (home-based CR used computer and Kinect) compared with the control group at the initial moment to the final moment measurement ($p = 0.021$; $\alpha < 0.05$) and compared to IG2 (Home-based CR used a paper booklet) on the measurement of the middle moment with the final moment ($p=0.001$; $\alpha < 0.05$), the initial moment with the final moment ($p=0.002$; $\alpha < 0.05$).

		schedule, it was recommended to walk every day for 30 minutes. The training protocol on IG1 and IG2 were the same. Monitor evaluation with the Borg scale of perceived exertion (normal range between 6 and 20).	
Sunamura, et al (2018)	To evaluate the effects of a multidisciplinary CR program on survival after Primary Primary Percutaneous Counseling (PPCI) treatments in patients with acute coronary syndrome.	Method: Propensity matching analysis Sample: A total of 1159 patients undergoing cardiac rehabilitation.	The results showed that patients who underwent the CR had a risk of death rate 0.61 times lower than patients who did not undergo the CR program (HR 0.61; 95% CI [0.46, 0.81). Most respondents, 915 respondents (78.8%) completed the CR program and had a lower mortality rate of 0.54 times compared to respondents who were uncomplete the CR program (HR 0.54; 95% CI 0.4 to 0.70).
Y. Zhang, Cao, Jiang, & Tang (2018)	To evaluate the effectiveness and safety of the application of cardiac rehabilitation in patients with acute myocardial infarction undergoing percutaneous coronary intervention	Method: Experimental Study Design Sample: 130 patients with acute myocardial infarction undergoing percutaneous coronary intervention were divided into 2 groups, such as rehabilitation group (n=65 respondents) and control group (n=65 respondents). Intervention: Rehabilitation Group: 1) Phase II began in the second week after the patient was discharged, which had 2 courses (each course 3-4 weeks); 2) The form of exercise was walking and aerobic; 3) Workload assignment: HR lower than 130 bpm (or resting HR plus 30 bpm), Borg Scale for exercise intensity measurement; 4) Respondents did physical exercise 2-3 times a week (interval or continuous) for 15-30 minutes; 5) Phase III started from the third month to 6 months; 6) The target HR was 60-75% of the maximal HR; 7) Th RPE score was no >12-16; 8) Exercise intensity was 300-400 kcal/time; 8) The intensity was 30-45 min/time, not <3-5 times a week. Control Group: Usual care + conventional drug therapy after percutaneous coronary intervention	The study results showed that there was a significant difference between the cardiac rehabilitation group and the control group regarding the recurrence of angina pectoris ($p = 0.002$; $\alpha < 0.05$), rehospitalization ($p < 0.001$; $\alpha < 0.05$). The mean distance for 6MWT phase II CR in the cardiac rehabilitation group was 324.09 meters with a standard deviation of 63.79 meters, while the mean in the control group was 257.86 meters with a standard deviation of 68.17 meters. The analysis showed that there was a significant difference in the 6MWT distance in the rehabilitation group and the control group ($p = 0.001$; $\alpha < 0.05$). The mean distance for 6MWT phase III CR in the cardiac rehabilitation group was 412.71 meters with a standard deviation of 74.37 meters, while the mean in the control group was 302.27 meters with a standard deviation of 101.81 meters. The analysis showed that there was a significant difference in the 6MWT distance in the rehabilitation group and the control group ($p = 0.001$; $\alpha < 0.05$).
Da Silva Chaves et al., (2019)	Knowing the effectiveness of comprehensive cardiac rehabilitation compared to respondents who participated in a physical exercise-based cardiac rehabilitation program or who did not participate.	Method: Single-Blinded, Single-Site, Pragmatic, Superiority RCT Sample: The total sample of 115 respondents were divided into 3 groups. 1st group (without CR program, n=39 respondent), 2nd group (exercise only, n=39 respondent), 3rd group (comprehensive CR, n=37 respondent) Intervention: In the comprehensive CR group, respondents were given 24 educational sessions supported by workbooks for 30 minutes before and after training. The 16 education sessions included exercises, diets, risk	Out of 115 total respondents, there were 93 respondents (80.9%) retained. The results was a significant increase in Incremental Shuttle Walk Test (ISWT) distance before and after in the comprehensive CR group (358.4 ± 132.6 to 464.8 ± 121.6 m; mean change = 106.4; $p < 0.001$; $\alpha < 0.05$) and CR-only group (391.5 ± 118.8 to 488.1 ± 106.3 m; mean change = 96.5, $p < 0.001$; $\alpha < 0.05$) which was greater functional capacity with comprehensive CR compared to controls (Intention-To-Treat [ITT]: mean difference 75.6 ± 30.7 m; 95% CI 1.4 to 150.2).

		management, and mental health delivered by physiotherapists, cardiologists, and nutritionists. The intervention was given for 6 months.	
Kasperowicz, Cymerys, & Kasperowicz (2019)	Evaluate the effects of cardiac rehabilitation on increasing exercise capacity in STEMI patients concerning sex, age, body mass index, diabetes, ejection fraction, and nicotine dependence.	Method: A retrospective chart review It was conducted to identify 100 patients who were treated in the department of cardiac rehabilitation in 2005-2015.	The results showed that there was a significant increase in exercise capacity ide +1 metabolic equivalent exercise ECG stress test and the 6-min walk test +75.4 minutes regardless of age, gender, body mass index, and nicotine dependence ($p < 0.05$).
Zhang & Chang (2019)	Analyze the results of a combination of PCI and physical exercise with PCI without physical training.	Method: Systematic Review through Embase, PubMed, Wanfang Data, Cochrane databases with 502 studies taken.	The results of the study contained 10 RCTs, namely 1,274 respondents (636 respondents in the intervention group and 638 control groups) showed that left ventricular ejection fraction (LVEF) increased significantly in the intervention group ($p < 0.05$, 95% CI 1.50, 4.14). The incidence of cardiac death ($p = 0.02$; $\alpha < 0.05$), myocardial infarction ($p = 0.002$; $\alpha < 0.05$), coronary angioplasty ($p = 0.01$; $\alpha < 0.05$), angina pectoris ($p = 0.002$); restenosis ($p = 0.02$; $\alpha < 0.05$) were significantly lower in the intervention group (the exercise group).
Q. Zhang (2019)	To evaluate the impact of cardiac rehabilitation on major adverse cardiac events (MACE) and mortality in patients with acute coronary syndrome.	Method: Systematic search in Cochrane Central Register of Controlled Trials, EMBASE, and PubMed from 2010 until August 2018 with 2,071 studies taken.	There were 25 studies with 55,035 respondents showed that the mortality rate was lower significantly in the CR group than the non-CR group (HR -0.47; 95% CI -0.56 to 0.39; $p < 0.05$). The risk of MACE was lower significantly in the CR group (RR 0.49; 95% CI 0.44 to 0.55; $p < 0.05$).
Petersen, Oestergaard, van Tulder, & Laustsen (2020)	Assess whether exercise-based cardiac rehabilitation with a higher exercise dose can increase muscle strength and aerobic capacity.	Method: Assessor Blinded Randomized Controlled Trial Sample: 164 patients with heart disease (n =82 respondents with high dosep, n = 82 respondents with low dose). Intervention: The study was divided into 2 groups, namely 1st group with a higher exercise dose (3 times a week for 12 weeks or as many as 36 sessions), while 2nd group was given exercise twice a week for 8 weeks or 16 sessions with the same intensity and standard exercise protocol for 1 hour.	The results showed that there were differences in VO_2 peak was 2.6 (0.4–4.8) mL kg^{-1} min^{-1} ($p=0.01$; $\alpha < 0.05$), maximal workload was 0.3 (0.03–0.5) W kg^{-1} ($p \leq 0.02$; $\alpha < 0.05$)), isometric muscle strength was 0.7 (0.1–1.2) N m kg^{-1} ($p \leq 0.02$; $\alpha < 0.05$), muscle power was 0.3 (0.03–0.6) W kg^{-1} ($p \leq 0.03$; $\alpha < 0.05$) significantly between the group with high-dose exercise and the group with low-dose exercise.
Prabhu, Maiya, & Prabhu (2020)	Reviewed the effects of CR related to the level of physical activity, functional capacity, and quality of life of patients undergoing coronary revascularization.	Method: Structured literature search in ProQuest, PubMed, Scopus, and CINAHL with a total of 2,020 studies taken.	There were 21 articles reviewed and the majority of studies report that physical activity and exercise programs based on home-based and center-based via rehabilitation include treadmills and cycle ergometry in phase 2 cardiac rehabilitation showing a significant increase in physical activity and functional capacity levels after the procedure coronary revascularization.

DISCUSSION

Functional Capacity

The results of the study by Da Silva et al., (2019) shows that ISWT distance before and after intervention in comprehensive CR group ($p < 0.001$; $\alpha < 0.05$) and CR-only group ($p < 0.001$; $\alpha < 0.05$) with functional capacity is greater with comprehensive CR compared to controls. Exercise or performance capacity is calculated by the metabolic equivalent of task (MET), which is equivalent to the activity. METs are consumed 3.5 mL of oxygen/kg body weight/min. MET maximum strength represents maximal oxygen consumption or max VO2. Physical exercise in CR increases stroke volume (SV) and increases oxygen consumption in the network (environmental agent). Physical training can improve blood flow to organs and improve the mitochondrial function of the skeletal muscle system and endothelial cell function. Besides physical exercise can also delay the accumulation of lactic acid in muscles and increase lung ventilation (Haybar, Habib., Shirani, Teimoor., Pakseresht, 2017).

Left Ventricular Ejection Fraction (LVEF)

The results of the study by H. Zhang & Chang, (2019) show that the left ventricular ejection fraction (LVEF) increases significantly in the intervention group ($p < 0.05$, 95% CI 1.50, 4.14). In CR patients are programmed to control blood pressure, reduce lipid levels, education for smoking cessation, diabetes control, reduce obesity, and lifestyle modification. Although physical exercise can affect the synthesis of free radicals, physical exercise also increases work capacity without simultaneously increasing the production of free radicals. This fact shows that physical exercise can be done with less oxidative stress and can reduce insulin resistance after myocardial infarction with hyperinsulinemia (Sadeghi et al., 2013).

The process of fibrinolysis and myocardial perfusion is improved after physical exercise and can improve systolic function and ventricular fraction ejection by increasing heart muscle. This is caused by the sympathetic influence that occurs during exercise so that the pulse rate increases (Sadeghi et al., 2013).

Medical Cost

The results of the study by Chen et al., (2015) show that the medical cost in CR group is lower than the non-CR group (HR 0.947; 95% CI 0.934, 0.981; $p = 0.042$). Myocardial infarction patients are managed on the clinical pathway (including CR administration) have a lower average length of stay (LOS) than patients who are not managed on a clinical pathway basis. This can affect the number of medical cost patients, meaning that patients undergoing cardiac rehabilitation are lower medical costs (Chen et al., 2015).

Recurrence

The study by (Chen et al., 2015) shows that the heart rehabilitation group is a lower risk of recurrence of acute myocardial infarction than the non-CR group (HR 0.640; 95% CI 0.197-1.863; $p = 0.004$). Patients undergoing cardiac rehabilitation are known to reduce the risk of reinfarction, functional status increases, and risk factors such as smoking or hypertension can be controlled. Besides, the CR program also involves multidiscipline conducted by a team of experts such as further education and counseling for patients after acute myocardial infarction thereby reducing the risk of recurrence (Dunlay, Shannon M., 2014).

Quality of Life (QoL)

The result of the study by Marita, Ina., Sastradimaja, Sunaryo B., Tiksnadi (2013) shows that a significant difference between the QoL before and after the intervention ($p = 0.001$; $\alpha < 0.05$). Quality of life is defined as a subjective, complex, and multidimensional concept that represents individual perceptions or subjective evaluations of functional status and well-being due to the effects of illness. QoL consists of 2 main components, namely physical and mental health. Based on the research results, it is known that the physical health component increased significantly in the intervention group compared to the control group. Aerobic exercise can increase the maximal arterial-venous O2 difference (A-V O2 Δ) and stroke volume which can increase the maximal exercise capacity (VO2 max).

Exercise-based rehabilitation can increase oxygen demand as measured by oxygen uptake ventilation (V̇O2). VO2 is determined by cardiac output and A-VO2. Increasing stroke volume or heart rate can cause an increase in Q. Q is determined by the heart rate and response to systolic blood pressure, absolute VO2, index or MO2 (myocardial oxygen) requirements. Increased VO2 max means that resulting in lower systolic blood pressure and slower heart rate, submaximal physical represents a smaller percentage of V̇O2 max, increases ventilation threshold, and decreases lower MO2 requirements.

CONCLUSION

Cardiac rehabilitation is an evidence-based intervention that includes physical exercise, health education, and modification of patient health behaviors. Cardiac rehabilitation is known to increase functional capacity, increase LVEF, reduce treatment costs, reduce the recurrence rate, and increase QoL of patients with CHD.

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