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Article

Clinical Effects of Hospital–Family Collaborative Cardiac Rehabilitation Training on Patients with Heart Failure after Cardiac Valve Prostheses

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Abstract

Background: Affected by factors, such as patients' age, course of disease, and underlying diseases, patients have high complications after cardiac valve replacement. This study applied hospital–family collaborative cardiac rehabilitation training to patients with heart failure undergoing cardiac valve prostheses and explored the clinical effect to provide guidance for postoperative rehabilitation. **Methods**: The clinical data of 213 patients with heart failure admitted to our hospital from January 2023 to January 2024 were retrospectively analyzed. After 12 cases who did not meet the inclusion criteria were excluded, 201 cases were finally included. In accordance with different nursing methods, patients were divided into reference group (n = 102) and observation group (n = 99). The reference group received routine nursing program, whereas the study group adopted hospital–family collaborative cardiac rehabilitation training on the basis of routine nursing. The levels of cardiac function indices [left ventricular ejection fraction (LVEF), left ventricular end-diastolic volume (LVEDV), left ventricular end-systolic volume (LVESV) and stroke volume (SV)], quality of life, cardiovascular risk factors [total cholesterol (TC), triglyceride (TG), and fasting blood glucose (FBG)] and the rehospitalization rate were compared between the two groups. **Results**: Before management, the levels of LVEF, LVEDV, LVESV, SV, quality-of-life scores, TC, TG, and FBG in the two groups were similar ($p > 0.05$). After management, the observation group had higher levels of LVEF, LVEDV, LVESV, and SV ($p < 0.001$); a better quality of life ($p < 0.001$); lower levels of TC, TG, and FBG ($p < 0.001$); and a lower rehospitalization rate ($p < 0.05$) than the reference group. **Conclusion**: Hospital–family collaborative cardiac rehabilitation training seems to improve the cardiac function indices of patients undergoing cardiac valve prostheses, and it has a certain clinical application value. However, the results should be promoted with caution, and more studies are needed to verify them.

Keywords

heart failure; heart valve disease; surgical procedures; operative; cardiac rehabilitation

Introduction

Heart failure is a heterogeneous clinical syndrome caused by cardiac overload and injury. This disease has a high morbidity and mortality, seriously affecting the quality of life of patients, and it has become an increasingly severe major public health problem [1,2]. About 6 million adults worldwide is estimated to suffer from heart failure [3]. The common cause of heart failure is heart valve disease [4]. Timely surgery of cardiac valve prostheses can slow the progression of heart failure, disability, and death [5]. Although cardiac valve prostheses can improve cardiac function, patients are prone to postoperative respiratory failure, and they have lengthened hospital stay due to physical weakness [6]. Lack of physical activity is a major problem in patients undergoing cardiac valve surgery. Patients may experience physical weakness, inability to move during hospitalization, and possible postoperative complications due to sternal healing [7]. Accidental readmission after cardiac valve prostheses is common, which places a heavy burden on patients and the health care system [8].

Cardiac rehabilitation training is an evidence-based intervention recommended by guidelines. It is suitable for patients with cardiac events or recovering from cardiac surgery, and it can improve patients' morbidity, mortality and functional status. However, cardiac rehabilitation training is traditionally provided in hospitals, thus limiting its popularity and participation, most notably due to barriers of cost, scheduling, and transportation [9]. Ritchey *et al*. [10] have shown that although cardiac rehabilitation training has been proven to improve the health status of patients, it is not ideal for clinical use due to the poor compliance of patients. Therefore, how to improve the clinical effect of cardiac rehabilitation training has become the direction of clinical thinking. Hospital–family collaborative cardiac rehabilitation training is a cardiac rehabilitation model that combines

hospital and family resources. Through remote guidance and indirect exercise supervision, this model enables patients to perform cardiac training rehabilitation while maintaining patients' contact with the cardiac rehabilitation centers of hospitals [11]. In the present study, hospital–family collaborative cardiac rehabilitation training was applied to patients undergoing cardiac valve prostheses to explore its clinical effects and provide reference and guidance for clinical practice.

Materials and Methods

Research Subjects

The clinical data of 213 patients with heart failure admitted to our hospital from January 2023 to January 2024 were retrospectively analyzed. After 12 cases were excluded, 201 cases were finally included as the study subjects. The data of all patients were collected from the database of our hospital. In accordance with different nursing methods, patients were divided into reference group (n = 102) and study group (n = 99). The reference group received routine nursing program, whereas the study group adopted hospital–family collaborative cardiac rehabilitation training on the basis of routine nursing. This study conformed to the relevant requirements of the Declaration of Helsinki [12]. It has been approved by the Ethics Committee of Central Hospital Affiliated to Shandong First Medical University (approval no.: 2023-191-01). Informed consent was obtained from all patients.

Inclusion criteria: (1) Patients met the Guidelines for the Diagnosis and Treatment of Heart Failure in China (2018) [13]. (2) After drug therapy or cardiac resynchronization therapy, and other adjuvant therapy, patients still had symptoms of heart failure and met the indications of cardiac valve prostheses. (3) Patients had a life expectancy of >1 year. (4) Patients had normal consciousness. (5) Patients had complete clinical data.

Exclusion criteria: (1) Patients could not tolerate anticoagulant or antiplatelet drugs. (2) Patients had active endocarditis. (3) Patients had intracardiac thrombosis. (4) Patients had malignant tumors.

Methods

The reference group adopted perioperative routine nursing, and the specific steps were as follows: (1) Preoperative clinical evaluation and imaging evaluation were performed to determine the surgical indications and contraindications of patients and the surgical approach. (2) During surgery, the medical staff provided good management of anesthesia, positioning, and guide sheath and monitored patients' condition. (3) After surgery, patients' complications were observed and managed. (4) Before discharge, the medical staff provided health education and instructed patients to engage in early rehabilitation exercises.

The research group underwent hospital–family collaborative cardiac rehabilitation training on the basis of routine nursing (same as the reference group). (1) Training stage. A nursing team composed of the head nurse and nurses with rich clinical nursing experience in cardiovascular department trained the relevant personnel; learned the knowledge of heart failure, common complications and related nursing knowledge points; and implemented clinical nursing after passing the examination. As the team coordinator, the head nurse was responsible for quality control throughout the program implementation. The responsible nurse took charge of the formulation and implementation of specific interventions and cooperated with other members. (2) Nursing implementation stage. This training method referred to the exercise guidelines of the American Heart Association [14], and the steps were as follows: (1) In the hospitalization stage, the nursing staff prepared for early cardiac rehabilitation training in outpatient. During the exercise training, the patients' physical activity reached levels 4 or 5 on the Rating of Perceived Exertion or approximately 60% of maximum heart rate to achieve mild and moderate intensity of exercise. (2) In the discharge stage, the family cardiac rehabilitation training included 5 min of warm-up time (stretching), 20 min of aerobic exercise (walking, jogging, or gymnastics), and 5 min of cooling time (stretching). The detailed hospital–family collaborative cardiac rehabilitation training plan is shown in Table 1. (3) After surgery, a seminar was held in the ward to mobilize the participation of family members through active communication, raise the attention of patients' families to cardiac rehabilitation training, and discussed rehabilitation training plans with patients' families. In this manner, families could assist patients in rehabilitation training after discharge. (4) At discharge, health education manuals, which included information on related diseases, risk factors, and dietary counseling, were distributed to the patients. The medical staff conducted a follow-up by telephone once a week to understand patients' compliance with the training plan and encouraged them to practice. A WeChat group was established to supervise and guide patients' rehabilitation training. A wearable remote electrocardiogram (ECG) monitoring equipment was used (manufacturer: Shanghai Jumu Medical Equipment Co., Ltd.; origin: Shanghai, China; model: LDE-X7) to detect patients' basic vital signs to ensure the safety of the family rehabilitation program.

Observation Indicators

(1) Cardiac function indicators. A color Doppler ultrasound diagnostic instrument (manufacturer: Canon Inc.; specification: Aplio i900; origin: Tokyo, Japan) was used at discharge and 2 months after discharge for examination of echocardiography in patients, with a probe frequency

Table 1. Hospital–family collaborative cardiac rehabilitation training program.

Time	Training Plan
During hospitalization	
Within 12 h after surgery	Resting in bed, turning over in bed, moving limbs, and gradually sitting up to eat.
1 or 2 days after surgery	Trying to get out of bed and sit in a chair three times a day, no more than 30 min each time.
3 or 4 days after surgery	Walking slowly in the room three times/d, 10 min/time under one's help.
5 days after surgery	Walking around the corridor in wards three or four times/d, 10–20 min/time; self-defecation.
6 days after surgery	Walking slowly two times a day in the hospital accompanied by someone for 10–20 min.
From 7 days after surgery to discharge	Slow walking three times/d, 15 min/time; basic self-care in life.
During discharge	
First week after discharge	Outdoor walking (slow speed), one time/d, 5–10 min/time.
Second week after discharge	Outdoor walking (normal speed), two times/d, 5–10 min/time.
Third week after discharge	Outdoor walking (fast speed), two times/d, 10–20 min/time.
Fourth week after discharge	Outdoor jogging, one time/d, 10–15 min/time.
After fifth week of discharge	Maintaining a habit of jogging and gradually participating in social activities and work.

of 2.5 MHz. The patient was placed in left lateral position, and a probe was placed between the third and fifth ribs on the left side of the sternum. The parasternal long-axis view beside the sternum and subcostal four-chamber view were selected to observe the size of the heart chamber, the diameter of blood vessels, the thickness of the valve, the amplitude and coordination of ventricular walls, and the echo intensity of the myocardium. The left ventricular end-diastolic and end-systolic diameters were measured. The left ventricular ejection fraction (LVEF, normal range: 50%–70%), left ventricular end-diastolic volume (LVEDV, normal range: 108–132 mL), left ventricular end-systolic volume (LVESV, normal range: 29–61 mL), and stroke volume (SV, normal range: 60–80 mL) were calculated by the system.

(2) Quality of life. The Short Form 36 Health Survey (SF-36) [15] was used to assess the quality of life of patients at discharge and 2 months after discharge. The scale consisted of nine dimensions and included eight aspects of health [physical function (PF), role limitations due to physical health (RP), body pain (BP), general health (GH), vitality (VT), social function (SF), role limitations due to emotional problems (RE), and mental health (MH)], with a total of 36 items. A higher score indicated better quality of life.

(3) Cardiovascular risk factors. At discharge and 2 months after discharge, the levels of total cholesterol (TC, normal level: $<$5.18 mmol/L), triglyceride (TG, normal level: $<$1.70 mmol/L), and fasting blood glucose (FBG, normal level: 4.4–6.1 mmol/L) in patients were measured. The patients were advised not to perform any strenuous exercise nor overeat the day before the examination. In the morning of the next day, 3 mL of fasting blood was taken from the patients, extracted from the serum, and detected by an automatic biochemical analyzer (manufacturer: Beckman Company; model: DXC800 automatic biochemical analyzer; origin: Brea, CA, USA). The levels of FBG, TC, and TG in patients (in fasting state) were measured at 8 o'clock in the morning.

(4) Rehospitalization rate. The ratio of rehospitalization due to heart failure within 1 year was counted.

Statistical Analysis

The data in this study were processed by SPSS software (version: 26.0; manufacturer: International Business Machines Corporation; origin: Armonk, NY, USA). Enumeration data were indicated by [n (%)] and detected by χ^2 test. The Shapiro–Wilk test was performed to evaluate whether the continuous variables conformed to normal distribution in grouping. Continuous variables conforming to normal distribution were indicated by (mean $\pm$ standard deviation), and independent t test was performed for comparison between groups. Continuous variables that did not conform to normal distribution were expressed as M (P_{25}, P_{75}), and the Mann–Whitney U test was performed for comparison between groups. $p < 0.05$ indicated that the difference was statistically significant.

Results

General Data of Patients in Two Groups

The reference group included 61 males and 41 females. The quartile of age was 67.00 (61.00, 73.00) years old, and the quartile of disease course was 7.00 (5.00, 9.00) years. The observation group was composed of 60 males and 39 females. The quartile of age in this group was 67.00 (61.00, 74.00) years old, and the quartile of disease course was 7.00 (5.00, 9.00) years. The patients in the two groups had similar characteristics in terms of sex, age, and disease course ($p > 0.05$). The general data of the two groups are shown in Table 2.

Table 2. General data of patients in two groups [M (P_{25}, P_{75}), n (%)].

Projects	Reference group (n = 102)	Observation group (n = 99)	χ^2/Z	p
Sex			0.013	0.908
Male	61 (59.80)	60 (60.61)		
Female	41 (40.20)	39 (39.39)		
Age [years old, M (P_{25}, P_{75})]	67.00 (61.00, 73.00)	67.00 (61.00, 74.00)	−0.047	0.962
Course of disease [year, M (P_{25}, P_{75})]	7.00 (5.00, 9.00)	7.00 (5.00, 9.00)	−0.804	0.421
BMI [kg/m^2, M (P_{25}, P_{75})]	20.10 (18.78, 22.10)	21.00 (18.80, 22.40)	−0.915	0.360
Types of disease			0.039	0.844
Protopathy	75 (73.53)	74 (74.75)		
Secondary disease	27 (26.47)	25 (25.25)		
NYHA classification of heart failure			0.006	0.936
Grade III	49 (48.04)	47 (47.47)		
Grade IV	53 (51.96)	52 (52.53)		
Hospitalization time [day, M (P_{25}, P_{75})]	14.00 (10.00, 17.00)	12.00 (9.00, 16.00)	−1.718	0.086
Complications				
Diabetes	51 (50.00)	49 (49.49)	0.005	0.943
Hypertension	59 (57.84)	55 (55.56)	0.107	0.743
Hyperlipidemia	61 (59.80)	56 (56.57)	0.217	0.642
Smoking history			0.048	0.827
Yes	50 (49.02)	47 (47.47)		
No	52 (50.98)	52 (52.53)		
Drinking history			0.002	0.966
Yes	58 (56.86)	56 (56.57)		
No	44 (43.14)	43 (43.43)		
Educational level			0.149	0.928
Junior college or above	19 (18.63)	17 (17.17)		
Senior high school	28 (27.45)	26 (26.26)		
Junior high school and below	55 (53.92)	56 (56.57)		

Notes: BMI, body mass index; NYHA, New York heart association.

Cardiac Function Indices

Before management, the levels of LVEF, LVEDV, LVESV, and SV in the two groups were similar ($p > 0.05$). After management, these levels were higher in the observation group than in the reference group ($p < 0.001$), as detailed in Table 3.

Quality of Life

Before management, the quality of life in the two groups was similar ($p > 0.05$). After management, it was higher in the observation group than in the reference group ($p < 0.001$), as detailed in Table 4.

Cardiovascular Risk Factors

Before management, the levels of TC, TG, and FBG in the two groups were similar ($p > 0.05$). After management, these levels were lower in the observation group than in the reference group ($p < 0.001$), as detailed in Table 5.

Rehospitalization Rate

The rehospitalization rates within 1 year in the reference and observation groups were 41.18% (42/102) and 27.27% (27/99), respectively. The observation group had a lower rehospitalization rate within 1 year than the reference group ($\chi^2 = 4.308$, $p = 0.038$).

Discussion

In this study, the observation group had better efficacy than the reference group. The application of hospital–family collaborative cardiac rehabilitation training based on routine nursing has a good effect on the improvement of cardiac function and quality of life and the reduction in cardiovascular risk factors and rehospitalization rate. The reasons for the above results were analyzed to provide clinical reference and guidance for patients with heart failure who receive cardiac valve prostheses.

Hospital–family collaborative cardiac rehabilitation training is an innovative rehabilitation training model, which provides patients with a comprehensive and person-

Table 3. Cardiac function indices in two groups [M (P_{25}, P_{75})].

Indicators	Time	Reference group (n = 102)	Observation group (n = 99)	Z	*p*
LVEF (%)	Before management	28.50 (25.75, 33.00)	29.00 (24.00, 32.00)	−1.123	0.261
	After management	34.00 (32.00, 37.00)	48.00 (41.00, 54.00)	−10.934	<0.001
LVEDV (mL)	Before management	72.50 (67.00, 77.00)	72.00 (68.00, 76.00)	−0.289	0.772
	After management	82.00 (77.00, 85.00)	99.00 (93.00, 104.00)	−11.623	<0.001
LVESV (mL)	Before management	17.00 (15.00, 19.00)	17.00 (15.00, 18.00)	−1.390	0.164
	After management	26.00 (21.00, 30.00)	29.00 (23.00, 32.00)	−3.680	<0.001
SV (mL)	Before management	46.00 (43.75, 50.25)	47.00 (44.00, 50.00)	−0.298	0.766
	After management	55.00 (50.75, 61.00)	63.00 (54.00, 68.00)	−6.130	<0.001

LVEF, left ventricular ejection fraction; LVEDV, left ventricular end-diastolic volume; LVESV, left ventricular end-systolic volume; SV, stroke volume.

Table 4. Quality of life scores in both groups [M (P_{25}, P_{75}), points].

Indicators	Time	Reference group (n = 102)	Observation group (n = 99)	Z	*p*
PF	Before management	60.50 (57.75, 63.00)	59.00 (57.00, 62.00)	−1.067	0.286
	After management	68.00 (64.00, 71.00)	77.00 (73.00, 80.00)	−10.542	<0.001
RP	Before management	60.00 (57.00, 62.00)	60.00 (58.00, 63.00)	−0.928	0.354
	After management	68.00 (64.00, 72.00)	76.00 (73.00, 80.00)	−10.151	<0.001
BP	Before management	61.00 (58.00, 63.00)	60.00 (57.00, 62.00)	−1.899	0.058
	After management	66.50 (63.00, 70.25)	77.00 (73.00, 80.00)	−11.006	<0.001
GH	Before management	59.50 (56.75, 62.00)	59.00 (57.00, 62.00)	−0.102	0.918
	After management	67.50 (63.00, 73.00)	76.00 (72.00, 80.00)	−9.594	<0.001
VT	Before management	61.00 (58.00, 63.00)	60.00 (57.00, 62.00)	−1.583	0.113
	After management	69.00 (64.00, 72.00)	77.00 (73.00, 81.00)	−9.990	<0.001
SF	Before management	60.00 (57.00, 62.00)	61.00 (57.00, 63.00)	−0.485	0.627
	After management	66.50 (62.00, 71.00)	76.00 (73.00, 80.00)	−10.600	<0.001
RE	Before management	60.00 (57.00, 63.00)	60.00 (57.00, 62.00)	−0.324	0.746
	After management	67.50 (64.75, 72.00)	76.00 (73.00, 80.00)	−10.162	<0.001
MH	Before management	60.00 (57.00, 63.00)	60.00 (58.00, 63.00)	−0.996	0.319
	After management	67.50 (64.00, 71.00)	77.00 (74.00, 80.00)	−10.709	<0.001

PF, physical function; RP, role limitations due to physical health; BP, body pain; GH, general health; VT, vitality; SF, social function; RE, role limitations due to emotional problems; MH, mental health.

Table 5. Cardiovascular risk factors in two groups [M (P_{25}, P_{75})].

Indicators	Time	Reference group (n = 102)	Observation group (n = 99)	Z	*p*
TC (mmol/L)	Before management	5.48 (5.13, 5.75)	5.47 (5.12, 5.76)	−0.297	0.766
	After management	5.09 (4.87, 5.28)	4.65 (4.28, 5.02)	−8.030	<0.001
TG (mmol/L)	Before management	1.88 (1.71, 2.10)	1.86 (1.72, 2.08)	−0.027	0.979
	After management	1.73 (1.60, 1.96)	1.56 (1.38, 1.75)	−6.152	<0.001
FBG (mL)	Before management	5.98 (5.79, 6.26)	5.96 (5.84, 6.23)	−0.059	0.953
	After management	5.76 (5.57, 5.98)	5.52 (5.20, 5.86)	−4.450	<0.001

TC, total cholesterol; TG, triglyceride; FBG, fasting blood glucose.

alized rehabilitation program by combining the resources and advantages of hospitals and families. Good doctor–patient communication can distinctly improve patients' compliance. In the hospital–family collaborative cardiac rehabilitation training, doctors can timely understand the rehabilitation of patients at home and provide necessary guidance and advice. This bidirectional communication mechanism helps establish a trust relationship and further improve patients' compliance. (1) Social support is one of the important driving factors for patients to adhere to rehabilitation training [16]. The collaborative management between hospitals and families makes the doctor–patient relationship close. In the process of multifaceted guidance for patients, doctors can help patients overcome many difficulties encountered in the rehabilitation process, make them feel intimate and concerned, provide necessary social support for them, and promote their implementation of cardiac rehabilitation training programs. (2) Hospital–family collabora-

tive cardiac rehabilitation training integrates exercise training into daily life, makes life more diversified, helps patients change their lifestyles, and further improves patients' participation and persistence. (3) A specific and detailed rehabilitation plan for patients can further improve the implementation of rehabilitation plan. One study has shown that the standard exercise program based on the characteristics of patients can improve patients' compliance [17]. After surgery, a phased rehabilitation training plan detailed to the weekly arrangement of rehabilitation can determine the psychological identity of patients during hospitalization and discharge. (4) Follow-up greatly improved the compliance of patients. Remote monitoring ensures that patients carry out effective rehabilitation training constantly, and the understanding and confidence of patients' families are confirmed [18].

An important feature of heart failure is the lack of exercise in patients. Training is internationally recognized as a first-level recommendation for patients with heart failure; it helps improve the cardiac ejection fraction, improve the quality of life, and reduce the number of hospitalizations and mortality [19]. Kitzman *et al*. [20] have shown that the physical function of patients hospitalized for heart failure overtly improved after rehabilitation interventions compared with that after routine nursing. Epstein *et al*. [21] indicated that cardiac rehabilitation training can improve patients' athletic ability, mental health, and overall quality of life, and it has become an increasingly important tool. Liu *et al*. [22] have shown that comprehensive rehabilitation training can improve the cardiac function indices of patients; reduce the physiological indices, such as the levels of TC, TG, and FBG; and improve patients' compliance with treatment. The above studies support the results of the present study. The implementation of hospital–family rehabilitation training can improve patients' compliance with rehabilitation training programs, thus achieving ideal results.

Although some clinical results were achieved, this study still has some limitations. (1) This study is a retrospective study. The data were extracted from the existing records, which may introduce selective bias and cannot directly infer the causal relationship. (2) Limited by time, manpower, and financial resources, this study has a limited sample size, which may lead to insufficient statistical efficiency. The follow-up study needs to select large samples. (3) Due to short follow-up time, the differences in long-term value between different management methods were not studied. Follow-up studies need to extend the follow-up time to comprehensively evaluate the clinical effects of hospital–family collaborative cardiac rehabilitation training. (4) This study included patients with a life expectancy of more than 1 year only to ensure the integrity of patient data and reduce the possibility of loss of patients in the middle, which may lead to data loss and potential selection bias.

Conclusion

The application of hospital–family collaborative cardiac rehabilitation training in patients with heart failure after cardiac valve prostheses seems to exert enhanced clinical effects. This method can improve patients' cardiac function indices and quality of life and reduce cardiovascular risk factors and readmission rate. It also a has good clinical value.

Availability of Data and Materials

The datasets used and/or analyzed during the current study were available from the corresponding author on reasonable request.

Author Contributions

LZ and MW designed the research study. LZ and HS performed the research. MW and HS provided help and advice on the ELISA experiments. HS analyzed the data. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study has been approved by the ethics committee of Central Hospital Affiliated to Shandong First Medical University, approval No. 2023-191-01. Informed consent was obtained from the patients and their families for this study.

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Conflict of Interest

The authors declare no conflict of interest.

References

[1] Snipelisky D, Chaudhry SP, Stewart GC. The Many Faces of Heart Failure. Cardiac Electrophysiology Clinics. 2019; 11: 11–20.

[2] Tomasoni D, Adamo M, Lombardi CM, Metra M. Highlights in heart failure. ESC Heart Failure. 2019; 6: 1105–1127.

[3] Chen J, Aronowitz P. Congestive Heart Failure. The Medical Clinics of North America. 2022; 106: 447–458.

[4] Crestanello JA. Mitral Valve Surgery for Congestive Heart Failure. Heart Failure Clinics. 2018; 14: 585–600.

[5] Kumar RK, Antunes MJ, Beaton A, Mirabel M, Nkomo VT, Okello E, *et al*. Contemporary Diagnosis and Management of Rheumatic Heart Disease: Implications for Closing the Gap: A Scientific Statement From the American Heart Association. Circulation. 2020; 142: e337–e357.

[6] Rios S, Li W, Mustehsan MH, Hajra A, Takahashi T, Chengyue J, *et al*. Impact of Frailty on Outcomes After Transcatheter Edge-to-Edge Repair With MitraClip (from the National Inpatient Sample Database). The American Journal of Cardiology. 2022; 179: 58–63.

[7] Abraham LN, Sibilitz KL, Berg SK, Tang LH, Risom SS, Lindschou J, *et al*. Exercise-based cardiac rehabilitation for adults after heart valve surgery. The Cochrane Database of Systematic Reviews. 2021; 5: CD010876.

[8] Borregaard B, Dahl JS, Riber LPS, Ekholm O, Sibilitz KL, Weiss M, *et al*. Effect of early, individualised and intensified follow-up after open heart valve surgery on unplanned cardiac hospital readmissions and all-cause mortality. International Journal of Cardiology. 2019; 289: 30–36.

[9] Isakadze N, Kim CH, Marvel FA, Ding J, MacFarlane Z, Gao Y, *et al*. Rationale and Design of the mTECH-Rehab Randomized Controlled Trial: Impact of a Mobile Technology Enabled Corrie Cardiac Rehabilitation Program on Functional Status and Cardiovascular Health. Journal of the American Heart Association. 2024; 13: e030654.

[10] Ritchey MD, Maresh S, McNeely J, Shaffer T, Jackson SL, Keteyian SJ, *et al*. Tracking Cardiac Rehabilitation Participation and Completion Among Medicare Beneficiaries to Inform the Efforts of a National Initiative. Circulation. Cardiovascular Quality and Outcomes. 2020; 13: e005902.

[11] Cardiovascular Disease Prevention and Rehabilitation Committee of the Chinese Society of Rehabilitation Medicine, Chinese Society of Gerontology and Geriatrics, Cardiovascular Disease Committee. Chinese expert consensus on hospital-led home cardiac rehabilitation. Chinese Journal of Internal Medicine. 2021; 60: 207–215. (In Chinese)

[12] World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013; 310: 2191–2194.

[13] Heart Failure Group of the Cardiovascular Disease Branch of the Chinese Medical Association, Heart Failure Specialized Committee of the Chinese Physicians Association, Editorial Committee of the Chinese Journal of Cardiovascular Disease. China heart failure diagnosis and treatment guidelines 2018. Chinese Journal of Cardiovascular Disease. 2018; 46: 760–789. (In Chinese)

[14] Paluch AE, Boyer WR, Franklin BA, Laddu D, Lobelo F, Lee DC, *et al*. Resistance Exercise Training in Individuals With and Without Cardiovascular Disease: 2023 Update: A Scientific Statement From the American Heart Association. Circulation. 2024; 149: e217–e231.

[15] Ware JE, Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Medical Care. 1992; 30: 473–483.

[16] Collado-Mateo D, Lavín-Pérez AM, Peñacoba C, Del Coso J, Leyton-Román M, Luque-Casado A, *et al*. Key Factors Associated with Adherence to Physical Exercise in Patients with Chronic Diseases and Older Adults: An Umbrella Review. International Journal of Environmental Research and Public Health. 2021; 18: 2023.

[17] Pennestrì F, Negrini F, Banfi G. La riabilitazione dopo artroplastica di ginocchio. Un approccio multidisciplinare e accelerato [Rehabilitation after knee arthroplasty. An accelerated multidisciplinary approach.]. Recenti Progressi in Medicina. 2020; 111: 82–90. (In Italian)

[18] Ding H, Jayasena R, Chen SH, Maiorana A, Dowling A, Layland J, *et al*. The Effects of Telemonitoring on Patient Compliance With Self-Management Recommendations and Outcomes of the Innovative Telemonitoring Enhanced Care Program for Chronic Heart Failure: Randomized Controlled Trial. Journal of Medical Internet Research. 2020; 22: e17559.

[19] Taylor JL, Myers J, Bonikowske AR. Practical guidelines for exercise prescription in patients with chronic heart failure. Heart Failure Reviews. 2023; 28: 1285–1296.

[20] Kitzman DW, Whellan DJ, Duncan P, Pastva AM, Mentz RJ, Reeves GR, *et al*. Physical Rehabilitation for Older Patients Hospitalized for Heart Failure. The New England Journal of Medicine. 2021; 385: 203–216.

[21] Epstein E, Rosander A, Pazargadi A, Taub P. Cardiac Rehab for Functional Improvement. Current Heart Failure Reports. 2020; 17: 161–170.

[22] Liu X, Zou Y, Huang D, Lu H. Effect of evidence-based nursing combined with exercise rehabilitation in patients with acute myocardial infarction after percutaneous coronary intervention. American Journal of Translational Research. 2022; 14: 7424–7433.