Guidelines for Rehabilitation in Patients With Cardiovascular Disease (JCS 2012)

– Digest Version –

JCS Joint Working Group

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(Circ J 2014; 78: 2022–2093)

Released online July 22, 2014

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This English language document is a revised digest version of Guidelines for Rehabilitation in Patients with Cardiovascular Disease reported at the Japanese Circulation Society Joint Working Groups performed in 2011 (Website: http://www.j-circ.or.jp/guideline/pdf/JCS2012_nohara_d.pdf).

Joint Working Groups: The Japanese Circulation Society, The Japanese Coronary Association, The Japanese Association for Thoracic Surgery, The Japanese Society of Pediatric Cardiology and Cardiac Surgery, The Japanese College of Cardiology, The Japanese Association of Cardiac Rehabilitation, The Japanese Society of Electrocardiology, The Japanese Heart Failure Society, The Japanese Physical Therapy Association, The Japanese Society of Clinical Sports of Medicine

ISSN-1346-9843 doi:10.1253/circj.CJ-66-0094

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Introduction of the Revised Guidelines

The Japanese Circulation Society (JCS) has published guidelines covering many aspects of cardiovascular diseases. The JCS guidelines have become increasingly popular, and more important in clinical practice. We revised the guidelines for rehabilitation in patients with cardiovascular diseases to reflect newly obtained, evidence-based information on cardiac rehabilitation, and to describe in more detail psychological approaches to rehabilitation, secondary prevention of cardiovascular diseases, and the importance of cardiac rehabilitation in women. Because the importance of cardiac rehabilitation is not adequately understood in Japan compared to in other developed countries, physicians should be responsible for educating and encouraging patients who have cardiovascular diseases to participate in cardiac rehabilitation. We hope the present guidelines will help physicians provide appropriate rehabilitation to patients who need it.

In the present guidelines, the recommendations are classified as follows according to the system used in other JCS guidelines:

Class I: The benefits, usefulness, and efficacy of a procedure or treatment have been demonstrated in multiple multicenter randomized controlled trials (RCTs).

Class II: Some discrepancy exists in findings or opinions regarding the benefits, usefulness, and efficacy of a procedure or treatment.

Class IIa: The benefits, usefulness, and efficacy of a procedure or treatment have been demonstrated in a small number of multicenter RCTs.

Class IIa': Although multicenter RCTs have not been conducted, the benefits, usefulness, and efficacy of a procedure or treatment are supported by multiple observational studies or expert opinions.

Class IIb: The benefits, usefulness, and efficacy are not well demonstrated by the results of multicenter RCTs.

Class III: A procedure or treatment has been demonstrated not to be effective or useful, and possibly harmful at times, or its harmfulness has been widely agreed upon.

The level of evidence used for guideline recommendations was classified as follows:

Level of Evidence A: Data are derived from multiple multicenter RCTs in ≥ 400 patients or in meta-analyses.

Level of Evidence B: Data are derived from multicenter RCTs in ≤ 400 patients, well-controlled comparative studies, or large cohort studies.

Level of Evidence C: No RCTs have been conducted, but there is a consensus among the experts.

Table 1. Definition of the Phases of Cardiac Rehabilitation

Phase	Phase I		Phase II		Phase III
Timing	- Acute phase	- Early recovery phase	- Late recovery phase	- Maintenance phase	
Location	- ICU/CCU	- General cardiovascular ward	- Outpatient/ambulatory rehabilitation center	- Community exercise center	
Purpose	- Return to daily life	- Returning to society	- Returning to society - Establish new lifestyle	- Comfortable life - Prevention of recurrence	
Contents	- Functional assessment - Care planning - Bedside physical therapy - Sitting/standing test - 30–100m walking test	- Pathophysiological/functional assessment - Mental status/psychological assessment - Education on the importance of rehabilitation - Exercise stress test - Exercise prescription - Instruction on ADLs, diet and drug treatment - Counseling - How to deal with handicaps - Support for return to work	- Pathophysiological/functional assessment - Mental status/psychological assessment - Exercise stress test - Exercise prescription - Exercise training - Instruction on ADLs, diet and drug treatment - Group sessions - Counseling - Modification of coronary risk factors	- Maintain better lifestyle - Modification of coronary risk factors - Exercise prescription - Exercise training - Group sessions	

ADL, activities of daily living; CCU, cardiac care unit; ICU, intensive care unit.

Adapted from Itoh H. Chapter 6. Recovery phase rehabilitation. In: Takano T, editor. Acute myocardial infarction, 2nd edn, Book 4 of ABC for new diagnosis and treatment. Tokyo: Saishin Igaku Sha, 2009; 278–286.¹

In the present guideline document, the phases of cardiac rehabilitation are classified into phase I (acute phase), phase II (recovery phase), and phase III (maintenance phase) (See [Table 1](#)).¹ The contents of cardiac rehabilitation differ among

the phases. The duration of the acute and early recovery phases has been shortened in year 2000 and thereafter, and the lifelong prevention of secondary cardiovascular diseases has increasingly been emphasized.

Abbreviations

AAA: abdominal aortic aneurysm	LVAD: left ventricular assist device
ABPI: ankle-brachial pressure index	LVAS: left ventricular assist system
ACCF/AHA: American College of Cardiology Foundation/ American Heart Association	LVEF: left ventricular ejection fraction
ACLS: advanced cardiac life support	MD: minutes distance
ACSM: American College of Sports Medicine	MDD: major depressive disorder
ADL: activities of daily living	METs: metabolic equivalents
AED: automated external defibrillator	MHQ: Marianna Heart Failure Questionnaire
AMI: acute myocardial infarction	MI: myocardial infarction
ASO: arteriosclerosis obliterans	MLHF: Minnesota Living with Heart Failure
ASV: adaptive servo-ventilation	MOS SF-20: Medical Outcome Study 20-item Short Form Health Survey
AT: anaerobic threshold	MOS SF-36: Medical Outcome Study 36-Item Short-Form Health Survey
AT $\dot{V}O_2$: oxygen uptake at anaerobic threshold	MR: magnetic resonance
BLS: basic life support	MRA: magnetic resonance angiography
BMI: body mass index	NaSSA: noradrenergic and specific serotonergic antide- pressant
BNP: natriuretic peptide	NEAT: non-exercise activity thermogenesis
BP: blood pressure	NGSP: National Glycohemoglobin Standardization Pro- gram
BRS: baroreflex sensitivity	NHI: National Health Insurance
CABG: coronary artery bypass grafting	NO: nitric oxide
CAD: coronary artery disease	NYHA: New York Heart Association
CAG: coronary angiography	OSA: obstructive sleep apnea
CCU: cardiac care unit	PAD: peripheral arterial disease
CHD: congenital heart disease	PCI: percutaneous coronary intervention
CK: creatine kinase	PCPS: percutaneous cardiopulmonary support
CKD: chronic kidney disease	peak $\dot{V}O_2$: peak oxygen uptake
CPAP: continuous positive airway pressure	PHQ-9: Patient Health Questionnaire-9
CPX: cardiopulmonary exercise test	PVC: premature ventricular contraction
CRP: C-reactive protein	PVR: pulse volume recording
CRT: cardiac resynchronization therapy	QALY: quality-adjusted life-year
CRT-D: cardiac resynchronization therapy defibrillator	RCT: randomized controlled trial
CSA: central sleep apnea	RPE: ratings of perceived exertion
CSR: Cheyne-Stokes respiration	SBP: systolic blood pressure
CSR-CSA: central sleep apnea with Cheyne-Stokes res- piration	SDB: sleep-disordered breathing
CT: computed tomography	SIP: Sickness Impact Profile
CTR: cardiothoracic ratio	SNRI: serotonin and norepinephrine reuptake inhibitors
eNOS: endothelial nitric oxide synthase	SPO ₂ : percutaneous arterial oxygen saturation
EOV: exertional oscillatory ventilation	SSRI: selective serotonin reuptake inhibitors
HADS: Hospital Anxiety and Depression Scale	SSS: sick sinus syndrome
HbA1c: hemoglobin A1c	STEMI: ST elevation myocardial infarction
HDL: high-density lipoprotein	TAA: thoracic aortic aneurysm
HOT: home oxygen therapy	TC: total cholesterol
HR: heart rate	TG: triglyceride
HRQOL: health-related quality of life	TNF: tumor necrosis factor
HRVI: heart rate variability index	$\dot{V}O_2$: oxygen uptake
IABP: intra-aortic balloon pumping	VWF: velocity wave form
ICD: implantable cardioverter defibrillator	WIQ: Walking Impairment Questionnaire
ICT: information and communication technology	1RM: one repetition maximum
ICU: intensive care unit	
KCCQ: Kansas City Cardiomyopathy Questionnaire	
LDL: low-density lipoprotein	

I Healthcare Environment Regarding Cardiac Rehabilitation

1. Healthcare Costs for Cardiac Disease in Japan

Data concerning healthcare costs and lengths of hospitalization by diagnosis in Japan indicate that patients with ischemic heart disease are decreasing in number and are hospitalized for an increasingly shorter period of time, while healthcare costs for cardiac disease are increasing. These data suggest that patients with ischemic heart disease receive intensive treatment within a short period of time. Healthcare procedures reimbursed as “fees for cardiovascular rehabilitation” in the National Health Insurance (NHI) in Japan were significantly expanded in the medical service fee revision in 2006. However, the number of patients undergoing NHI-covered cardiovascular rehabilitation is still small.

bilitation is still small.

2. Healthcare Cost and NHI Reimbursement for Cardiac Rehabilitation

In Japan, the cost for 1 session of rehabilitation in patients with cardiovascular diseases (cardiac rehabilitation) is estimated to be between 4,000 and 5,000 yen per person. The NHI reimbursement for cardiac rehabilitation is set to cover the cost. A questionnaire survey in 186 hospitals certified as cardiac rehabilitation providers revealed that the profits from cardiac rehabilitation vary widely among hospitals, but are surplus in most of the hospitals.²

II Effects and Mechanism of Exercise Training

1. Physical Effects

Level of Evidence: A

1. Exercise training improves exercise capacity;
2. improves the quality of life (QOL) of patients by reducing symptoms associated with activities of daily living (ADL);
3. prevents deterioration of left ventricular systolic function and left ventricular remodeling;
4. decreases the incidence of coronary events;
5. decreases the hospitalization rate due to exacerbation of ischemic heart failure;
6. improves prognosis in patients with ischemic heart failure and coronary artery disease (CAD);
7. decreases systolic blood pressure; and
8. increases high-density lipoprotein (HDL) cholesterol levels, and decreases triglyceride levels.

Level of Evidence: B

1. Exercise training decreases heart rate and ventilatory volume at the same intensity physical activities;
2. improves left ventricular diastolic function;
3. is expected to reduce excessive sympathetic nervous activity;
4. prevents the progression of coronary artery atherosclerotic lesions;
5. decreases levels of inflammatory reactions such as C-reactive protein (CRP) and proinflammatory cytokines;
6. reduces platelet aggregation and blood coagulation activity; and
7. improves baroreflex sensitivity (BRS).

Level of Evidence: C

1. Exercise training decreases total peripheral vascular resistance at rest and during exercise;
2. increases maximum arteriovenous oxygen difference;
3. improves myocardial perfusion;
4. improves endothelial function in coronary arteries and peripheral arteries; and
5. increases mitochondrial density and the activities of oxidative enzymes in skeletal muscle, and promotes the conversion from type II to type I muscle fiber.

Exercise training has been demonstrated to improve the physical effects listed in [Table 2](#).^{3–38} In patients with chronic CAD, cardiac rehabilitation may be as effective as drug treatment and catheter intervention in terms of the improvement of prognosis.^{6,57}

1. Increase in Exercise Capacity

Improvement in exercise capacity is one of the most reliable effects of exercise training, and it has been reported that the peak oxygen uptake (peak $\dot{V}O_2$) as an index of exercise capacity, increases by 15–25% after exercise training in patients with cardiovascular diseases.^{3–34} As a relative intensity of the same physical activity is reduced, exercise training alleviates exercise-induced symptoms, such as shortness of breath and anginal pain, associated with daily activities. The improvement in exercise capacity is assumed to be due to an increase in myocardial ischemic threshold in patients with CAD,^{6,23,24} and improvements in peripheral effects such as peripheral circulation and skeletal muscle function in patients with chronic heart failure.^{11,21,22}

2. Increase in Muscle Strength After Resistance Training

Relatively low intensity resistance training has been established to be safe in patients with cardiovascular diseases. Resistance training is expected to enhance the strength of major muscle groups, facilitate ADLs, and improve the QOL of patients with chronic heart failure and low muscle strength.⁵⁸

3. Effects on Cardiac Function and Ventricular Remodeling

It has been demonstrated that exercise training does not deteriorate left ventricular remodeling, but rather decreases left ventricular end-diastolic volume and improves exercise capacity in patients with chronic heart failure.^{9,13,39,40} It has also been suggested that exercise training may prevent postinfarction ventricular remodeling.⁹ An increasing number of reports have described that exercise training improves left ventricular diastolic function,^{17,18,39} and also improves left ventricular systolic function slightly.^{12,39–41}

4. Effects on Coronary Circulation

Exercise training increases the myocardial ischemic threshold by improving myocardial perfusion.^{23,24,28} It has been pointed out that decreased coronary vasodilator reserve plays a role in

Table 2. Physical Effects of Exercise Training

Category	Effects	Rank
Exercise capacity	Increase peak uptake	A ^{3–34}
	Increase anaerobic threshold	A ^{4,11,31,33}
Symptoms	Decrease the incidence of anginal attacks by increasing myocardial ischemic threshold	A ^{23,24,28}
	Reduce symptoms of heart failure associated with the same intensity physical activities	A ^{4,7,21,31}
Respiration	Decrease ventilatory volume at given submaximal workloads	A ^{30,31,33}
Heart	Decrease heart rate at given submaximal workloads	A ^{11–23}
	Decrease cardiac work (double product) at given submaximal workloads	A ²³
	Prevent left ventricular remodeling	A ^{9–13,39–41}
	Prevent the deterioration of left ventricular systolic function	A ^{9–13,39–41}
	Improve left ventricular diastolic function	B ^{17,18,39}
	Improve myocardial metabolism	B ^{19,20}
Coronary arteries	Prevent the progression of coronary atherosclerotic lesions	A ^{24–27}
	Improve myocardial perfusion	B ^{23,24,28}
	Improve endothelium-dependent and -independent vasodilation responses	B ^{29,42}
Peripheral oxygen utilization	Increase the maximum arteriovenous oxygen difference	B ^{21,22}
Peripheral circulation	Decrease total peripheral vascular resistance at rest and during exercise	B ^{11,21}
	Improve peripheral arterial endothelial function	B ^{43–45}
Inflammatory reactions	Decrease CRP and proinflammatory cytokines	B ^{46–48}
Skeletal muscle	Increase mitochondrial density	B ^{49,50}
	Increase the activity of oxidative enzymes in skeletal muscle	B ^{38,39}
	Increase capillary density in skeletal muscle	B ^{38,39}
	Promote the conversion from type II to type I muscle fiber	B ^{38,39}
Coronary risk factors	Decrease systolic blood pressure	A ^{3,35,38,51}
	Increase HDL cholesterol and decrease triglycerides levels	A ^{3,35,38,51}
	Decrease smoking rate	A ^{3,35,38}
Autonomic nervous system	Reduce the sympathetic nervous activity	A ^{7,52,53}
	Increase parasympathetic nervous activity	B ^{7,52,53}
	Improve the baroreflex sensitivity	B ⁵²
Blood	Reduce platelet aggregation	B ⁵⁴
	Reduce blood coagulation	B ^{55,56}
Prognosis	Reduce the incidence of coronary events	A ^{5,6,35,36}
	Reduce hospitalization rate due to exacerbation of heart failure	A (CAD) ^{4,37}
	Improve prognosis (reduce all-cause mortality and cardiac death)	A (CAD) ^{4–6,35–37}

A, supported by substantial evidence; B, supporting reports are high in quality but limited in number; CAD, coronary artery disease; CRP, C-reactive protein; HDL, high-density lipoprotein.

the development of myocardial ischemia. Exercise training may enhance coronary perfusion by improving endothelium-dependent and -independent vasodilation responses even if coronary artery lesions remain unchanged.²⁹ Studies of comprehensive programs, including diet therapy, and exercise training, revealed that these programs not only prevented the progression of coronary artery lesions but also induced regression of coronary artery lesions, and decreased the incidence of coronary events. The favorable effects of exercise training only without other intervention have also been reported.^{24–27}

5. Improvement in Ventilatory Function

Exercise training reduces excessive ventilation and dyspnea by decreasing afferent nerve stimulation from skeletal muscles and enhancing respiratory muscle function.^{30–34}

6. Improvement in Autonomic Nervous System Function

Patients with cardiovascular diseases are prone to exhibit persistent sympathetic nervous activity, which contributes to the progression of heart failure and the occurrence of severe

arrhythmia. Exercise training reduces excessive sympathetic nervous activity, and enhances parasympathetic nervous activity.^{7,52,53}

7. Effects on Peripheral Circulation

In patients with chronic heart failure, blood flow in skeletal muscle does not increase appropriately during exercise. This is a major factor causing impaired exercise capacity,¹¹ and is suspected to be due to vascular endothelial dysfunction. Exercise training improves vascular endothelial function.⁴³

8. Improvement of Inflammatory Reactions

Proinflammatory reactions significantly participate in the pathophysiology of atherosclerosis and chronic heart failure. Exercise training has anti-inflammatory effects, and decreases levels of CRP and proinflammatory cytokines.^{46–48}

9. Adaptation of Skeletal Muscle to Exercise

Exercise training increases the capillary density of skeletal muscle, promotes a conversion from type II to type I muscle fiber,

and increases the number and oxidative enzyme activities of mitochondria.⁴⁷ These peripheral mechanisms play important roles in the increase in peak $\dot{V}O_2$ by exercise training.

10. Modification of Coronary Risk Factors

Exercise training is effective in modifying coronary risk factors. Comprehensive programs including exercise training have been confirmed to be effective in decreasing blood pressure, improving lipid metabolism and glucose tolerance, and promoting smoking cessation.^{3,35,38,59} Exercise training also decreases platelet aggregation and blood coagulation activity.^{54–56}

11. Improvement of Prognosis

It has been reported that exercise training improves the prognosis of patients with CAD and ischemic heart failure by decreasing the incidences of coronary events and hospitalizations for exacerbations of heart failure.^{4,35–37}

12. Sex Differences in the Effects of Exercise Training

It is known that women tend not to participate in cardiac rehabilitation,^{60–63} and the incidence, severity, and duration of depression after myocardial infarction (MI) are higher in female than in male patients.⁶⁴ Cardiac rehabilitation programs for women should be developed and the effects of such programs in women should be evaluated.⁶¹

2. Effects of Exercise Training on Mental Status and QOL

Effects of Exercise Training on Depression

Class I

None.

Class IIb

- Exercise training should be considered for CAD or chronic heart failure patients with depression. (**Level of Evidence: C**)

It has been reported that depression is common among patients with cardiovascular diseases, and the severity of the depression increase as worsening difficulty to perform ADLs especially in patients with chronic heart failure.⁶⁵ It is unclear whether depression directly affects prognosis in patients with CAD or chronic heart failure. Because few studies have conducted depression as the main outcome in investigating the effects of cardiac rehabilitation, further research regarding the efficacy of cardiac rehabilitation on depression will need.

Effects of Exercise Training on QOL

Class I

- Exercise training is strongly recommended to improve the QOL in patients after MI or coronary artery bypass grafting (CABG). (**Level of Evidence: A**)
- Exercise training is also strongly recommended to improve the QOL in patients with chronic heart failure. (**Level of Evidence: A**)

Class IIb

- The improvement in QOL by exercise training differs substantially by the severity of cardiovascular diseases, and the mode, intensity and duration of exercise training. (**Level of Evidence: C**)

The one of major purpose of cardiac rehabilitation is to improve health-related quality of life (HRQOL) in patients with cardiovascular diseases.

1. How to Assess QOL

QOL questionnaires frequently used in the cardiology field include the Sickness Impact Profile (SIP),⁶⁶ the MacMaster Health Index Questionnaire,⁶⁷ the Nottingham Health Profile,⁶⁸ and the Medical Outcome Study (MOS) 36-Item Short-Form Health Survey (SF-36).⁶⁹ Disease specific QOL questionnaires for cardiovascular diseases include the Minnesota Living with Heart Failure (MLHF) Questionnaire⁷⁰ and the Kansas City Cardiomyopathy Questionnaire (KCCQ).⁷¹ In Japan, the Marianna Heart Failure Questionnaire (MHQ)⁷² was developed as an evaluation of symptoms due to heart failure. It is recommended to apply disease specific QOL questionnaires in this patient population, because commonly used QOL measure such as SF-36 does not sufficiently consider the clinical features of cardiovascular diseases.

2. Effects of Cardiac Rehabilitation on QOL of Patients With Cardiovascular Diseases

The evidence has been established by a large number of RCTs which reported the favorable effects of cardiac rehabilitation on QOL in patients with CAD, including acute myocardial infarction (AMI) or CABG. The effects of exercise training on QOL in patients with chronic heart failure have also been reported in many RCTs, and evidence is being accumulated rapidly. While the effects of cardiac rehabilitation on the QOL has been demonstrated in chronic heart failure patients with systolic dysfunction only a few reports have described in chronic heart failure patients with preserved ejection fraction. Further studies needs to clarify in this regard. In Japan, it is expected that the number of the patients with heart transplantation or left ventricular assist device (LVAD) gradually increase and perform cardiac rehabilitation, so data on the effects of cardiac rehabilitation in these patient populations will need to be accumulated in the future.

There is also little evidence regarding the effect of cardiac rehabilitation on QOL in patients with peripheral vascular diseases. Further studies are required.

3. Methodology of Cardiac Rehabilitation to Improve QOL

The effects of comprehensive programs, exercise plus lifestyle modification, as well as exercise training on QOL have been reported. Studies of cardiac rehabilitation in patients with CAD and chronic heart failure have been conducted mainly performing programs combining exercise training and psychosocial approaches, however the results of these programs are controversial.

Regarding the type of exercise training, it has been well documented that a combination of aerobic exercise and resistance training is better than aerobic exercise alone in terms of the improvement in QOL. Recently, improvement in QOL has been reported in high-intensity interval training^{40,73–75} and electrical muscle stimulation therapy in patients with severe heart failure.⁷⁶ Further studies are required to establish evidence.

Almost all studies with successful results of the improvement in QOL performed cardiac rehabilitation for at least 16 weeks, suggesting that intervention period might be one of the determinants to obtain improvement in QOL.

Table 3. Goals for Blood Pressure Control

	Target blood pressure levels
Primary prevention	<140/90 mmHg
Secondary prevention of coronary artery disease	<130/80 mmHg at clinic <125/75 mmHg in home
Patients with diabetes (including impaired glucose tolerance) or CKD	<130/80 mmHg

CKD, chronic kidney disease.

Source: the Guidelines for the Primary Prevention of Ischemic Heart Disease (JCS 2006)⁹² and the Guidelines for Secondary Prevention of Myocardial Infarction (JCS 2011)⁹³ published by the Japanese Circulation Society, and the Japanese Society of Hypertension Guidelines for Management of Hypertension (JSH 2009)⁹⁴ published by the Japan Society of Hypertension.

Table 4. Goals for Lipid Control

Treatment rules / Category	Target lipid levels (mg/dL)			
	LDL-C	HDL-C	TG	Non HDL-C
Primary prevention: Modify lifestyle, then consider the indication for drug treatment				
Category I	<160	} ≥40	} <150	<190
Category II	<140			<170
Category III Patients with a history of diabetes, chronic kidney disease, non-cardiogenic cerebral infarction, or arteriosclerosis obliterans	<120			<150
Secondary prevention: Modify lifestyle and consider drug treatment				
Patients with a history of coronary artery disease	<100	≥40	<150	<130

- The above-listed values are targets to achieve.

- In all categories, lifestyle modification is the basis to achieve target lipid levels.

- For patients in category I, drug treatment should be considered for those with a LDL-C level of ≥180 mg/dL.

- Physicians may also consider targeting a reduction in LDL-C level by 20–30%.

- Goals for non HDL-C levels are secondary targets that should be tried in patients with hypertriglyceridemia in whom target LDL-C levels have been achieved. Non HDL-C levels should be used when TG levels exceed 400 mg/dL or blood samples are obtained after a meal.

*Please refer to the Japan Atherosclerosis Society (JAS) Guidelines for Prevention of Atherosclerotic Cardiovascular Diseases 2012 for the definition of categories, assessment of absolute risk of coronary artery disease (primary prevention), and lipid control in patients with familial hypercholesterolemia and elderly individuals (≥75 years of age).

HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride.

Adapted from the Japan Atherosclerosis Society (JAS) Guidelines for Prevention of Atherosclerotic Cardiovascular Diseases 2012,⁹⁵ with modification.

3. Effects of Cardiac Rehabilitation on the Secondary Prevention of Cardiovascular Diseases

1. Improvement of Prognosis by Exercise Training and Its Mechanism

Class I

- Exercise training is expected to decrease all-cause mortality in patients with CAD; (**Level of Evidence: A**)
- decreases cardiac mortality in patients with CAD; (**Level of Evidence: A**) and
- decreases the incidence of recurrent fatal MI. (**Level of Evidence: A**)

Class IIa

- Exercise training is expected to increase heart rate variability and BRS by enhancing parasympathetic nervous activity, and to reduce excessive sympathetic nervous activity and heart rate. (**Level of Evidence: B**)

Class IIa'

- Exercise training is expected to prevent plaque rupture by stabilizing coronary atherosclerotic lesions; (**Level of Evidence: C**) and

- alleviates the inflammation that drives the progression of coronary atherosclerosis. (**Level of Evidence: C**)

Meta-analyses of studies that evaluated the effects of exercise training on the secondary prevention of CAD and on improving in short-term mortality of prognosis have provided Level A scientific evidence.^{5,6,77,78} However, conclusive Level A evidence has not been obtained in terms of long-term (≥10-year) prognosis (**Level of Evidence: B**).⁷⁹ In addition to the modifying of coronary risk factors, exercise training has been reported to improve prognosis by stabilizing coronary atherosclerotic lesions, and favorably affecting endothelial function and autonomic function (**Level of Evidence: B**).^{6,78,80} No strong evidence has been found in terms of whether exercise training may prevent plaque rupture by stabilizing coronary atherosclerotic lesions and alleviating inflammation to slow or prevent the progression of coronary atherosclerosis.^{81–84}

2. Modification of Atherosclerotic Risk Factors

Class I

- Cardiac rehabilitation is expected to exert mild antihypertensive effect. (**Level of Evidence: A**)
- Cardiac rehabilitation is expected to improve lipid profile. (**Level of Evidence: A**)
- Comprehensive programs including long-term diet therapy

Table 5. Goals for Body Weight Control

Primary prevention	BMI* <25.0 kg/m ² Waist circumference: <85 cm for males, <90 cm for females
Secondary prevention	BMI* 18.5–24.9 kg/m ² Waist circumference: <85 cm for males, <90 cm for females

*BMI, body mass index (calculated as body weight [kg]÷[height in meters]²).

Source: the Guidelines for the Primary Prevention of Ischemic Heart Disease (JCS 2006)⁹² and the Guidelines for Secondary Prevention of Myocardial Infarction (JCS 2011)⁹³ published by the Japanese Circulation Society.

Table 6. Goals for Diabetes Management

Primary prevention	Absence of diabetes (including impaired glucose tolerance)
Secondary prevention	HbA1c (NGSP) <7.0%

HbA1c, hemoglobin A1c; NGSP, National Glycohemoglobin Standardization Program.

Source: the Guidelines for the Primary Prevention of Ischemic Heart Disease (JCS 2006)⁹² and the Guidelines for Secondary Prevention of Myocardial Infarction (JCS 2011)⁹³ published by the Japanese Circulation Society.

Table 7. Alcohol Content of Beverages

Beverages	Alcohol content (%)	Serving size	Volume (mL)	Ethanol content (mL)
Beer, low-malt beer	5	1 can	350	17.5
Wine	15	A wine glass	110	16.5
Shochu (distilled spirits)	25	A glass of shochu mixed with hot water (1:1)	90	22.5
Sake	15	180 mL	180	27.0
Whiskey, brandy	40	A single shot	30	12.0
Chinese rice wine	17	A small glass	50	8.5

Ethanol content=Volume of beverage (mL)×(alcohol content [%]÷100).

are expected to improve body weight control. (**Level of Evidence: A**)

- Combination of diet therapy and exercise training is expected to decrease the incidence of cardiovascular events in patients with insulin-dependent diabetes. (**Level of Evidence: A**)

Class II

- Patient education is expected to be helpful in encouraging smoking cessation and body weight control. (**Level of Evidence: A**)

Modification of atherosclerotic risk factors such as hypertension,^{25,35,85,86} diabetes,^{87,88} and dyslipidemia^{35,89,90} (i.e., hyper-low-density lipoprotein [LDL] cholesterolemia and hypo-HDL cholesterolemia) is important to improve prognosis, and Level A evidence on the effects of exercise training on these risk factors has been accumulated. However, conventional exercise training programs exert short-term effects on body weight control and smoking cessation,²⁵ but are not sufficient to en-

sure long-term modification of risk factors. Because women tend not to continue cardiac rehabilitation, long-term comprehensive programs that include appropriate patient education should be developed.⁹¹ It has become aware that comprehensive programs improve prognosis by modifying not only atherosclerotic risk factors but also multiple risk factors.^{80,89}

Recommendations for modification of atherosclerotic risk factors are summarized as follows:

- Hypertension (**Table 3**)^{92–94}
- Dyslipidemia (**Table 4**)⁹⁵
- Smoking; complete smoking cessation and avoidance of passive smoking are essential in primary and secondary prevention of cardiovascular diseases.
- Obesity; (body weight control) (**Table 5**)^{92,93}
- Diabetes (**Table 6**)^{92,93}
- Patient education
- Alcoholic beverages; abstinence or a restriction to light alcohol consumption (20–30 mL ethanol per day for men, 10–20 mL ethanol per day for women) should be encouraged (**Table 7**).

III General Rules of Exercise Training

Class I

- Prior to beginning exercise training programs, participants should be assessed for clinical status and undergo examinations at rest and exercise stress tests to determine the ap-

propriateness of exercise training and to establish the appropriate exercise prescriptions. (**Level of Evidence: A**)

- Exercise training should be considered as a measure to treat lifestyle-related diseases that increase the risk of CAD.

(Level of Evidence: A)

- Exercise training should be considered as an intervention for patients with CAD, including angina pectoris and MI.

(Level of Evidence: A)

The following sections describe important considerations in exercise prescriptions for healthy individuals and patients with cardiovascular diseases in terms of selection of participants, risk stratification, medical check-ups, general rules in prescribing exercise prescriptions, and precautions of exercise training. **Figure 1** shows a flowchart of exercise training for patients with cardiovascular diseases.

1. Selection of Participants and Risk Stratification in Prescribing Exercise Training Programs

To provide effective and safe exercise prescriptions for healthy individuals, individuals who have risk factors for atherosclerosis, and patients with cardiovascular diseases, physicians should select participants appropriately on the basis of medical history, physical findings, and medical evaluation. Participants should be stratified by risk according to the severity of cardiovascular diseases and presence/absence of noncardiovascular complications.

1. Medical Check-ups for Exercise Training (Table 8)⁹⁶

Prior to beginning exercise training programs, candidates, including apparently healthy individuals, should be assessed for clinical status and undergo examinations at rest and exercise stress tests to determine the appropriateness of exercise training for individual participants and to establish the appropriate exercise prescription. Clinical status should be assessed through medical interviews about subjective symptoms, medical history, family history, and lifestyle. Medical check-ups should include measurement of blood pressure, pulse rate, electrocardiographic activity.⁹⁶ Levels of blood glucose, total cholesterol,

triglycerides, hepatic enzymes, and body mass index should also be evaluated.⁹⁷

2. Exercise Stress Test (Tables 9 and 10)⁹⁸

Exercise stress test is important in determining whether exercise training is indicated for individual patients. The present guideline document does not describe the indications and methods of exercise stress test in detail. In brief, exercise stress test, as part of the medical check-ups conducted prior to the initiation of exercise training, is necessary for patients with cardiac disease, patients with signs/symptoms of cardiovascular diseases such as chest pain, shortness of breath, and intermittent claudication, and patients with coronary risk factors such as diabetes and dyslipidemia.⁹⁹

3. Exercise Training for Patients With Lifestyle-Related Diseases and Metabolic Syndrome (Table 11)

Exercise training is effective in the treatment of lifestyle-related diseases.^{100,101} Comprehensive programs including exercise training and diet therapy are important for the treatment of hypertension, diabetes, and dyslipidemia. After the definition of the concept and diagnostic criteria of metabolic syndrome as the basis of these lifestyle-related diseases, the “Exercise and Physical Activity Reference for Health Promotion 2006 (EPAR 2006): Physical Activity, Exercise, and Physical Fitness” and the “Exercise and Physical Activity Guide for Health Promotion 2006 ~ To Prevent Lifestyle-related Diseases ~ <Exercise and Physical Activity Guide for Health Program 2006>” were published by the Office for Lifestyle-related Diseases Control, General Affairs Division, Health Service Bureau, the Ministry of Health, Labor and Welfare (MHLW) of Japan.^{102,103}

4. Exercise Training for Patients With Ischemic Heart Disease

Patients after AMI account for a large population of patients receiving exercise training as rehabilitation after CAD. Exercise training for patients after AMI is generally classified into three phases: phase I (acute phase) during intensive care unit

Table 8. Basic Medical Information Required to Prescribe Exercise Training Programs

Basic medical information	Exercise stress test	Other measures
Symptoms		
Chest pain, chest discomfort, palpitation, shortness of breath	Required	
Dizziness, syncope, intermittent claudication	Required	
Spine symptoms, joint symptoms		Orthopedic examination/ consultation
Medical history		
Cardiovascular diseases	Required	
Orthopedic diseases		Orthopedic examination/ consultation
Lifestyle-related diseases		
Hypertension	See hypertension in Table 11	Severity assessment
Diabetes	See diabetes in Table 11	Severity assessment
Dyslipidemia	See dyslipidemia in Table 11	Severity assessment
Obesity	See obesity in Table 11	Severity assessment
Family history*		
Myocardial infarction or sudden death in first-degree relatives	Required	
Lifestyle		
Exercise, diet, smoking, drinking		Lifestyle intervention
ECG at rest		
Myocardial infarction	Required	
Abnormal ST-T	Required	
Ventricular arrhythmia	Required	
Other important findings	Required	

*Careful assessment is required for patients whose first-degree relative(s) experienced cardiovascular events at a relatively younger age, i.e., patients whose father or other first-degree male relative or mother or other first-degree female experienced myocardial infarction, coronary revascularization, or sudden death at <55 and <65 years of age, respectively.

Adapted from Japan Medical Association. Exercise training prescription manual. *Japan Medical Association Journal* 1996; **116**(Suppl): 1–49,⁹⁶ with modification.

Table 9. Contraindications for Exercise Stress Test**Absolute contraindications**

1. Acute myocardial infarction developed within 2 days
2. Unstable angina not controlled with medical treatment
3. Uncontrolled arrhythmia that cause symptoms or hemodynamic compromise
4. Symptomatic severe aortic stenosis
5. Uncontrolled symptomatic heart failure
6. Acute pulmonary embolism or pulmonary infarction
7. Acute myocarditis or pericarditis
8. Acute aortic dissection
9. Mental disorders associated with communication difficulties

Relative contraindications

1. Left main coronary artery stenosis
2. Moderate stenotic valvular heart disease
3. Electrolyte abnormality
4. Severe hypertension*
5. Tachyarrhythmia or bradyarrhythmia
6. Hypertrophic cardiomyopathy or other outflow tract obstruction
7. Mental or physical impairment leading to inability to exercise adequately
8. Advanced atrioventricular block

*It is recommended that severe hypertension is suggested as a systolic blood pressure of >200 mmHg and/or a diastolic blood pressure of >110 mmHg, in principle.

Adapted from Gibbons RJ, et al. ACC/AHA Guidelines for Exercise Testing. *J Am Coll Cardiol* 1997; **30**: 260–311,⁹⁸ with permission from Elsevier Inc., modified for Japanese patients.

/cardiac care unit (ICU/CCU) treatment; phase II (recovery phase) consisting of the early recovery phase in the general cardiovascular ward to discharge from hospital, and the late

recovery phase from immediately after discharge to returning to work; and phase III (maintenance phase) after returning to work. However, in Japan, the recovery phase is defined as the

Table 10. Criteria for Terminating Exercise Test

1. Symptoms	Anginal pain, dyspnea, syncope, dizziness, light-headed feeling, leg pain (claudication)
2. Signs	Cyanosis, facial pallor, cold sweat, ataxia
3. Blood pressure	Insufficient increase or progressive decrease in systolic blood pressure during exercise, or abnormal increase in blood pressure (≥ 225 mmHg)
4. ECG	Apparent ischemic ST-T changes, cardiac rhythm disorder (e.g., severe tachycardia or bradycardia, ventricular tachycardia, frequent arrhythmias, atrial fibrillation, R on T, and premature ventricular contractions), and second or third degree atrioventricular block

Source: Gibbons RJ, et al. ACC/AHA Guidelines for Exercise Testing. *J Am Coll Cardiol* 1997; **30**: 260–311.⁹⁸

Table 11. Indications and Contraindications for Exercise Training in Lifestyle-Related Diseases

Diagnosis	Indications	Conditional indications	Contraindications
Hypertension	140~159/90~94 mmHg	BP of 160~179/95~99 mmHg; ongoing antihypertensive treatment with BP less than the contraindicated level; men over 40 years and women over 50 years should undergo exercise stress tests whenever possible. If exercise stress tests are not feasible, prescribe walking or other light exercise.	BP of $\geq 180/100$ mmHg; chest X-ray findings with a CTR of $\geq 55\%$; ECG indicating severe arrhythmia or ischemic changes (excluding those with favorable results of exercise stress tests); hypertensive changes (IIb or higher) on funduscopy; urinary protein of ≥ 100 mg/dL
Diabetes	Fasting blood glucose level: 110~139 mg/dL	Fasting blood glucose level of 140~249 mg/dL; ongoing antidiabetic treatment with glucose levels less than the contraindicated level; men over 40 years and women over 50 years should undergo exercise stress tests whenever possible. If exercise stress tests are not feasible, prescribe walking or other light exercise.	Fasting blood glucose level of ≥ 250 mg/dL; positive urinary ketones; diabetic retinopathy
Dyslipidemia	TC: 220~249 mg/dL or TG: 150~299 mg/dL	TC ≥ 250 mg/dL or TG ≥ 300 mg/dL, ongoing lipid management; men over 40 years and women over 50 years should undergo exercise stress tests whenever possible. If exercise stress tests are not feasible, prescribe walking or other light exercise.	
Obesity	BMI: 24.0~29.9	BMI: 24.0~29.9, detailed assessment for leg joint disorder; limitation of exercise	BMI: ≥ 30.0

BMI, body mass index (calculated as body weight [kg] $\div$ [height in meters]²); BP, blood pressure; CTR, cardiothoracic ratio; TC, total cholesterol; TG, triglycerides.

Adapted from Japan Medical Association. Exercise training prescription manual. *Japan Medical Association Journal* 1996; **116**(Suppl): 1–49,⁹⁶ with modification.

first 5 months of treatment during which costs for cardiac rehabilitation are covered by the NHI, and the maintenance phase is defined as month 6 and thereafter, regardless of whether the patient achieved returning to work. The reader should refer to other sections of this document for the contents of exercise training for patients with CAD.

5. Exercise Training for Patients With Other Types of Cardiovascular Diseases

In the revision of the NHI reimbursement in April 2005, indications of “cardiovascular rehabilitation” were expanded to include cardiac rehabilitation programs provided in medical institutions registered to the relevant social insurance office for patients with large vessel diseases (e.g., aortic dissection, after large vessel surgery), chronic heart failure (left ventricular ejection fraction [LVEF] of $\leq 40\%$; peak $\dot{V}O_2$ of $\leq 80\%$ of the reference value; or brain natriuretic peptide [BNP] of ≥ 80 pg/mL), and patients with peripheral arterial occlusive diseases complicated with intermittent claudication, in addition to the conventional three indications of patients with angina pectoris, those with MI, and those who have had open heart surgery. The reader should refer to Chapter IV-5 “Acute and Chronic Heart Failure” and Chapter VII “Exercise Training for Large Vessel and Peripheral Arterial Diseases”.

6. Risk Stratification for Complications During Exercise Training

The indications of cardiac rehabilitation are expanding, and a wide variety of patients are being introduced to exercise training programs. Because the response to exercise training may vary among patients, healthcare professionals should understand the clinical status of individual patients to provide individualized training programs appropriate for each patient. The American Heart Association (AHA) stratifies patients undergoing exercise training according to symptoms and cardiac function, and recommends activity guidelines, supervision, and ECG monitoring for stratified participants according to the risk stratification (Table 12).⁹⁹ This classification may also be applied to patients in Japan.

2. General Rules for Exercise Prescriptions

Exercise prescriptions are developed to improve physical condition by enhancing exercise capacity and modifying coronary risk factors, and to confirm the safety of exercise training. Exercise prescriptions consist of (1) the type of exercise, (2) exercise intensity, (3) duration of exercise, and (4) the frequency of exercise, and (5) are modified after improvement in

Table 12. Indications, Contraindications, and Risk Classification for Exercise Training

Cardiovascular conditions and clinical findings	Limitations and monitoring
Class A: Apparently healthy individuals	
1. Men <45 years and women <55 years who have no symptoms or known presence of coronary risk factors	Activity guidelines: No restrictions.
2. Men ≥45 years and women ≥55 years who have no symptoms or known presence of cardiac disease and with <2 cardiovascular risk factors	Supervision required: None.
3. Men ≥45 years or women ≥55 years who have no symptoms or known presence of cardiac disease and with ≥2 cardiovascular risk factors	ECG and blood pressure monitoring: Not required.
Class B: Presence of known, stable cardiovascular disease with low risk for complications with vigorous exercise, but slightly greater than for apparently healthy individuals	
This classification includes individuals with any of the following diagnoses:	Activity guidelines: Exercise prescriptions should be individualized.
1. Stable coronary artery disease	Supervision required: Medical supervision during initial prescription session is beneficial.
2. Mild or moderate valvular heart disease, excluding severe valvular stenosis or regurgitation	
3. Congenital heart disease	Supervision by appropriate trained nonmedical personnel for other exercise sessions should occur until the individual understands how to monitor his or her activity. Medical personnel should be trained and certified in ACLS. Nonmedical personnel should be trained and certified in BLS.
4. Cardiomyopathy: ejection fraction ≤30%; excluding hypertrophic cardiomyopathy or recent myocarditis	
5. Exercise test abnormalities that do not meet any of the high risk criteria outlined in class C below	ECG and blood pressure monitoring: Useful during the early prescription phase of training, usually 6 to 12 sessions.
Clinical characteristics (must include all of the following):	
1. NYHA classification of Class I or II	
2. Exercise capacity ≤6 METs	
3. No evidence of congestive heart failure	
4. No evidence of myocardial ischemia at rest or on the exercise test at or below 6 METs	
5. Appropriate rise in systolic blood pressure during exercise	
6. Absence of sustained or nonsustained ventricular tachycardia at rest or during exercise	
7. Ability to satisfactorily self-monitor intensity of activity	
Class C: Those at moderate-to-high risk for cardiovascular complications during exercise and/or unable to self-regulate activity or to understand recommended activity level	
This classification includes individuals with any of the following diagnoses:	Activity guidelines: Exercise prescriptions should be individualized.
1. CAD	Supervision: Medical supervision during all exercise sessions until safety is established.
2. Mild or moderate valvular heart disease, excluding severe valvular stenosis or regurgitation	
3. Congenital heart disease	ECG and blood pressure monitoring: Continuous during exercise sessions until safety is established, usually ≥12 sessions.
4. Cardiomyopathy: ejection fraction <30%; includes stable patients with heart failure but not hypertrophic cardiomyopathy or recent myocarditis	
5. Complex ventricular arrhythmias not well controlled	
Clinical characteristics (any of the following):	
1. NYHA classification of Class III or IV	
2. Exercise stress test results	
- Exercise capacity <6 METs	
- Ischemic ST depression at a workload <6 METs	
- Fall in systolic blood pressure below resting levels during exercise	
- Nonsustained ventricular tachycardia during exercise	
3. Previous episode of cardiac arrest with unknown cause (excluding cardiac arrest associated with myocardial infarction)	
4. A medical problem that the physician believes may be life-threatening	
Class D: Unstable disease with activity restriction	
This classification includes individuals with any of the following:	Activity guidelines: No activity is recommended until conditions improve.
1. Unstable angina	
2. Severe and symptomatic valvular heart disease	
3. Congenital heart disease	
4. Heart failure that is not compensated	
5. Uncontrolled arrhythmias	
6. Other medical conditions that could be aggravated by exercise	

ACLS, advanced cardiac life support; BLS, basic life support; CAD, coronary artery disease; NYHA, New York Heart Association; METs, metabolic equivalents.

Adapted from Fletcher GF, et al. Exercise standards for testing and training. *Circulation* 2001; **104**: 1694–1740,⁹⁹ with permission from Wolters Kluwer Health.

Table 13. Exercise Training Programs

Exercise training programs include warm-up, resistance training, endurance training, and cool-down.

Examples:

Warm-up: stretching, warm-up exercise, low-intensity (slow) walking

Main exercises: aerobic exercise and resistance training at prescribed intensity

Cool-down: low-intensity (slow) walking, stretching, cooling-down exercise

[Aerobic exercise]

Intensity	Intensity			Duration of one session (minutes)	Frequency	
	% peak $\dot{V}O_2$	Karvonen value (k value)	RPE (Borg scale)		Sessions/day	Days/week
Low intensity	20~<40%	0.3~<0.4	10~<12	5~10	1~3	3~5
Moderate intensity	40~<60%	0.4~<0.6	12~13	15~30	1~2	3~5
High intensity	60~70%	0.6~0.7	13	20~60	1~2	3~7

[Resistance training]

Intensity	Strength		Frequency		
	% of 1RM	RPE (Borg scale)	Repetitions per set	Sets per exercise/day	Training sessions per week (days/week)
Low intensity	20~30%	10~11	8~15	1~3	2~3
Moderate intensity	40~60%	11~13	8~15	1~3	2~3
High intensity	80%	13~16	8~15	1	2~3

Note: % peak $\dot{V}O_2$ and %1RM are calculated from actual measured value of individuals, and are not percentages of age-specific reference values.

peak $\dot{V}O_2$, peak oxygen uptake; 1RM, one repetition maximum; RPE, ratings of perceived exertion.

Source: American College of Sports Medicine. ACSM's Guidelines for Exercise Testing and Prescription, 7th edn, 2005,⁹⁷ and Fletcher GF, et al. Exercise standards for testing and training. *Circulation* 2001; **104**: 1694–1740.⁹⁹

Table 14. Borg Scale for Ratings of Perceived Exertion (RPE)

Scale	RPE	Exercise intensity (%)
20	Maximum exertion	100
19	Very, very hard	95
18		
17	Very hard	85
16		
15	Hard	70
14		
13	Somewhat hard	55 (corresponding to AT)
12		
11	Fairly light	40
10		
9	Very light	20
8		
7	Very, very light	5
6		

AT, anaerobic threshold.

Source: Borg GA. Perceived exertion. *Exerc Sport Sci Rev* 1974; **2**: 131–153.¹⁰⁴

exercise capacity. Exercise intensity is classified into low, moderate and high categories. [Tables 13^{97,99}](#) and [14¹⁰⁴](#) list the typical physical responses to, and the training loads for, low-, moderate- and high-intensity exercise training. Exercise training programs consist of warm-up, endurance training, resistance training, additional activities such as recreation, and cool-down. The reader should refer to the unabridged version of the guidelines for specific points and factors to be considered when developing exercise prescriptions.^{97,105}

3. General Guidelines for Exercise Training in the Patients With Cardiovascular Diseases

General guidelines for exercise training in the patients with cardiovascular diseases include a) exercise only when feeling physically well; b) do not exercise vigorously soon after eating; c) adjust exercise to the weather; d) wear proper clothing and shoes; e) understand personal limitations; f) select appropriate exercises; and g) be alert for symptoms.⁹⁹

IV Pathophysiology of Cardiovascular Diseases and Exercise Training

1. Myocardial Infarction

Acute Phase Rehabilitation

Class I

1. Ambulation in the early phase of hospitalization (≥ 12 hours after hospitalization) in patients with ST elevation myocardial infarction (STEMI) with neither recurrent ischemic

chest pain, heart failure symptoms, nor severe arrhythmias. (Level of Evidence: C)

2. Supervised cardiac rehabilitation/secondary prevention programs in patients for whom exercise training is not contraindicated, especially intermediate- or high-risk patients or those with multiple coronary risk factors. (Level of Evidence: C)

Table 15. Criteria for Evaluating the Results of an Exercise Stress Test Prior to Introducing Acute-Phase Rehabilitation in Patients With Acute Myocardial Infarction**Acute-phase rehabilitation can be introduced when the patient does not exhibit any of the following:**

1. Symptoms such as chest pain, dyspnea, and palpitation
2. An increase in heart rate to ≥ 120 bpm or by ≥ 40 bpm
3. The development of potentially dangerous cardiac arrhythmias
4. Ischemic ST depression of ≥ 1 mm, or significant ST elevation
5. A change in systolic blood pressure by ≥ 20 mmHg during the period before the patient was allowed to use a bedside commode
(The criteria for blood pressure are not used for patients 2 weeks after the onset of acute myocardial infarction.)

Patients who failed the exercise stress test should receive appropriate drug treatment or other measures, and undergo the same test on the next day.

Class IIa

1. To use a bedside commode after 12–24 hours of bed rest in patients with unstable hemodynamics or continued ischemia. **(Level of Evidence: C)**

Class III

1. Exercise stress test in the first 2–3 days after the onset of STEMI should avoid in patients with STEMI for whom reperfusion therapy has not been successful. **(Level of Evidence: C)**
2. Cardiac rehabilitation should avoid in patients with uncontrolled acute heart failure and those with persistent arrhythmias. **(Level of Evidence: C)**

Recovery Phase Rehabilitation**Class I**

1. Cardiac rehabilitation/secondary prevention programs for patients recovering from STEMI. **(Level of Evidence: B)**
2. Exercise at anaerobic threshold (AT) level, 40–60% of the peak $\dot{V}O_2$, 40–60% of maximum heart rate, or a Borg scale of 12–13. **(Level of Evidence: A)**
3. To perform 15–60 minute exercise sessions that are prescribed according to risk assessment by exercise at least 3 times a week (7 times whenever possible), and to increase their ADL. **(Level of Evidence: B)**

Class IIa

1. Submaximal exercise test on day 4 after onset or thereafter to predict prognosis, prescribe exercise training programs, and assess treatment efficacy. **(Level of Evidence: B)**
2. Symptom-limited exercise stress test on day 14–21 after onset to predict prognosis, prescribe exercise training programs, and assess treatment efficacy of cardiac rehabilitation. **(Level of Evidence: B)**
3. To promote long-term exercise adherence to increase the ADL and make exercise a daily habit. **(Level of Evidence: A)**
4. Exercise training for elderly patients in the same way as younger patients. **(Level of Evidence: A)**
5. Exercise training for clinically stable low-risk patients under proper instruction and supervision. **(Level of Evidence: A)**
6. Home-based exercise training programs with proper instruction and reporting. **(Level of Evidence: A)**

Class IIa'

1. Exercise training in patients with a large anterior wall infarction and poor cardiac function. **(Level of Evidence: B)**
2. Exercise training for patients 1–4 weeks after placement of their stents. **(Level of Evidence: B)**

MI results in physical and mental deconditioning. Cardiac rehabilitation is provided to enhance recovery from physical/mental deconditioning, reduce coronary risk factors, improve QOL, facilitate returning to work, and prevent recurrent MI or sudden death. The term cardiac rehabilitation refers to “coordinated, multifaceted interventions designed to optimize a cardiac patient’s physical, psychological, and social functioning, in addition to stabilizing, slowing, or even reversing the progression of the underlying atherosclerotic processes, thereby reducing morbidity and mortality”.^{78,106,107} Cardiac rehabilitation programs consist of (1) exercise training and prescription, (2) reduction of coronary risk factors and secondary prevention of cardiovascular disease, and (3) counseling on psychosocial factors and returning to work, and are classified by timing into the acute phase (phase I), early recovery phase (early phase II), late recovery phase (late phase II), and maintenance phase (phase III) programs (Table 1).¹⁰⁸

1. Effects of Exercise Training on Myocardial Infarction

Cardiac rehabilitation has beneficial effects on physical function, and improves the outcomes that are most important to patients. It has been demonstrated that exercise training has pleiotropic effects such as improvement in coronary risk factors, prevention of atherosclerosis progression, ischemic events and thrombogenesis, antiinflammatory effect, and enhancement of endothelial function, skeletal muscle metabolism, and autonomic nervous system function in patients with CAD.

2. Practice of Cardiac Rehabilitation in Patients With Myocardial Infarction

Cardiac rehabilitation for patients with AMI is classified into three phases, and each phase has specific goals. In Japan, cardiac rehabilitation provided during hospitalization had been defined as acute-phase rehabilitation. However, in the current practice, phase I acute-phase rehabilitation is provided immediately after hospitalization, and is followed by phase II rehabilitation consisting with early recovery-phase rehabilitation during hospitalization and late recovery-phase rehabilitation after discharge. After participating in phase II programs, patients enter phase III maintenance phase rehabilitation.

(1) Phase I (Acute Phase)

Acute-phase cardiac rehabilitation during the first 1 or 2 week after the onset of MI is provided to ensure that patients are able to perform personal care safely such as meal preparation, bathing, and toilet use, and to start education on secondary prevention of cardiovascular events in the early phase of hospitalization. Patients who have no complications and can successfully complete an in-room walking test are transferred to the general ward and start early recovery-phase rehabilitation

Table 16. A 14-Day Clinical Pathway for Patients With Acute Myocardial Infarction (From the National Cerebral and Cardiovascular Center)

Day	Goals	Patient care/stress test/rehabilitation	Activities	Meals	Excretion	Hygiene
Day 1 after PCI	- Prevent complications of AMI and catheter-related complications	- Remove the tourniquet, disinfect wounds - Allow use of a bedside commode	- After removing the tourniquet, allow the patient to move freely on the bed	- Regular diets for patients with cardiovascular diseases (1,600kcal/day, salt 6 g/day) - Set a water consumption limit	- Urine: Urinary catheter - Stool: Bedside commode	- Face washing: on the bed - Body cleaning: Bed-bath. A caretaker assists bed-bath of the feet and back
Day 2		- Remove the urinary catheter	- Allow the patient to move freely in the room			- Face washing: Use the washstand - Body cleaning: Bed-bath. A caretaker assists bed-bath of the feet and back
Day 3	- Prevent complications of AMI	- Remove the venous access device	- Allow the patient to walk to the toilet		- Urine and stool: Use the toilet	
Day 4	- No myocardial ischemia	- When patient can pass a 200 m walking test, conduct 200m walking sessions 3 times a day - Ask a dietitian to provide nutrition education	- Allow the patient to walk around the ward within a 200m radius of the room	- Regular diets for patients with cardiovascular diseases (1,600kcal/day, salt 6 g/day) - Allow drinking water freely		- Face washing: Use the washstand - Bed-bath: A caretaker assists bed-bath of the back
Day 5	- No myocardial ischemia - The patient can take his/her drugs as prescribed - The patient can access information about important points for daily living after discharge	- Order a cardiac rehabilitation program - Confirm when the cardiac rehabilitation program begins				
Day 6	about important points for daily living after discharge	- Conduct a submaximal exercise test at entry in the cardiac rehabilitation room - If the patient has not attended the cardiac rehabilitation, conduct a 500m walking test	- When patient passes a submaximal stress test, allow bathing, and walking freely in the hospital			- Face washing: Use the washstand - Provide bed-bath when requested by the patient
Day 7						
Day 8	- No myocardial ischemia	- Conduct exercise sessions at the cardiac rehabilitation room (If the patient has not attended the program, conduct a Master's single test or allow having a bath as a trial)				- Face washing: Use the washstand - Allow bathing when the patient wants to bathe
Day 9	- The patient can understand important points for daily living after discharge					
Day 10						
Day 11	- No ischemia at submaximal exercise					
Day 12	- The patient can list important points for daily living after discharge					
Day 13						
Day 14	Discharge					

AMI, acute myocardial infarction.

programs. [Table 15](#) lists criteria for the transition to the next phase. [Table 16](#) shows the clinical pathway that is used for patients with AMI during the first 14 days of hospitalization in the National Cerebral and Cardiovascular Center (NCVC).

(2) Early Phase II (Early Recovery Phase During Hospitalization)

The recovery phase is defined as a period from 1 week to 3 months after the onset of STEMI. During the recovery phase,

cardiac rehabilitation is provided to improve the range of physical activities and facilitate return to work and society with good mental and physical conditions by (1) conducting an exercise stress test to estimate prognostic risk, (2) providing proactive exercise training programs according to the individualized exercise prescription, (3) educating patients about secondary prevention and lifestyle intervention, and (4) providing comprehensive and systematic counseling on mental care and returning to work.

Table 17. How to Determine Exercise Intensity During the Late Recovery Phase (Late Phase II) of Cardiac Rehabilitation for Patients With Acute Myocardial Infarction

- A. 40–60% of HR reserve (=maximum HR–resting HR)
 Karvonen formula: $[\text{maximum HR} - \text{resting HR}] \times k + \text{resting HR}$
 $k=0.6$ for lower-risk patients (e.g., young patients with uncomplicated acute myocardial infarction), 0.4–0.5 for high-risk patients, and 0.3–0.5 for patients with heart failure
- B. HR at AT level or 40–60% of peak $\dot{V}O_2$
- C. RPE: Borg scale of 12–13 (fairly light–somewhat hard)
- D. Simple setting: Resting HR+30 bpm (resting HR+20 bpm for patients receiving β -blockers)

Exercise intensity should be low in high-risk patients i.e., those with (1) left ventricular dysfunction (LVEF <40%), (2) prolonged occlusion of the left anterior descending artery (patients who failed in reperfusion therapy), (3) patients with severe three-vessel disease, and (4) elderly patients (≥ 70 years old).
 AT, anaerobic threshold; HR, heart rate; LVEF, left ventricular ejection fraction; peak $\dot{V}O_2$, peak oxygen uptake; RPE, ratings of perceived exertion.

The widespread use of reperfusion therapy has substantially decreased the duration of hospitalization in patients with AMI, and patients do not have sufficient time to undergo recovery-phase cardiac rehabilitation during hospitalization. Because phase II cardiac rehabilitation is critical to prevent deterioration of QOL and prognosis, patients are recommended to enter recovery-phase cardiac rehabilitation programs during hospitalization, and continue outpatient recovery-phase (late phase II) cardiac rehabilitation programs after discharge.

(3) Late Phase II (Late Recovery Phase, Outpatient Programs)

After discharge for AMI, patients usually visit the clinic every other week for follow-up. At each visit, patients should participate in comprehensive programs including smoking cessation, dietary education and lifestyle intervention. Under the appropriate risk management, individualized exercise programs are designed to achieve recovery of ADL to the levels they were before the onset of MI (Table 17). Exercise stress test

Figure 3. Nationwide survey on the treatment of acute myocardial infarction in cardiovascular hospitals in Japan. AMI, acute myocardial infarction; CAG, coronary angiography; CPX, cardiopulmonary exercise test; JCS, Japanese Circulation Society; MHLW, Ministry of Health, Labor and Welfare; PCI, percutaneous coronary intervention. Adapted from Goto Y, et al. Poor implementation of cardiac rehabilitation despite broad dissemination of coronary interventions for acute myocardial infarction in Japan. *Circ J* 2007; **71**: 173–179.¹¹⁵

should be performed 1, 3, and 6 (or 5) months after onset or at the end of the phase II rehabilitation to reissue exercise prescription, evaluate the efficacy of exercise training, and assess the prognosis of the patients. The NHI System in Japan reimburses for most parts of cardiac rehabilitation programs for 150 days. After this period, patients should enter maintenance-phase cardiac rehabilitation.

(4) Phase III (Maintenance Phase, Outpatient Programs)

Maintenance-phase cardiac rehabilitation is provided to prevent recurrent cardiovascular events, and should be continued for life. Cardiac rehabilitation should be established as part of the patients' ADL.

3. Clinical Pathways for Myocardial Infarction

Patients with AMI are treated according to clinical pathways including acute-phase cardiac rehabilitation programs.¹⁰⁹ Because serious complications of AMI develop most frequently during the first week after onset, the NCVC is using the 14-day clinical pathway shown in Table 16 to care for patients who have been successfully treated with reperfusion therapy and have Killip I type AMI without complications with a peak creatine kinase (CK) level of $\geq 1,500$ U/L, while a 10-day clinical pathway is used to manage patients with small infarctions with peak CK levels of $< 1,500$ U/L. Figure 2 illustrates a rehabilitation program of NCVC for AMI patients from the acute to the chronic stage of the disease. Before encouraging patients to increase their ADL, patients undergo exercise stress test to monitor changes in symptoms, heart rate, blood pressure, and ECG during exercise. Table 15 shows the criteria for exercise stress test from the NCVC. On day 6 of onset and

thereafter, patients whom exercise training is not contraindicated should enter recovery-phase cardiac rehabilitation programs.

4. Local Collaborative Clinical Pathways Including Cardiac Rehabilitation for Acute Myocardial Infarction

Many of the medical institutions where cardiac rehabilitation is not available are small- or medium-sized hospitals. The most common reasons for unavailability of a rehabilitation program are a lack of staff members, exercise area, or suitable equipment.¹¹⁰ It is highly likely that such small- or medium-sized hospitals cannot satisfy the current MHLW requirements for providing cardiovascular rehabilitation or cannot treat a sufficiently large number of patients requiring cardiac rehabilitation. However, these medical institutions may establish "local clinical pathways including cardiac rehabilitation for AMI" by collaborating with local institutions that provide outpatient cardiac rehabilitation programs.¹¹¹

5. Patient Education

Because the duration of hospitalization has become shorter, and patients with AMI cannot receive sufficient education during their stay regarding secondary prevention, healthcare professionals should provide the minimum necessary information during the acute phase, and continue patient education during recovery-phase cardiac rehabilitation programs. During the acute-phase cardiac rehabilitation, healthcare professionals should (1) instruct the patient how to manage chest pain and provide contact information for when unmanageable chest pain occurs; (2) instruct the patient how to use nitroglycerin sublingual tablets or sprays; (3) encourage the patient and his/

her family members to learn how to perform cardiopulmonary resuscitation; (4) explain the patient's coronary risk factors; (5) motivate the patient to participate in cardiac rehabilitation and improve lifestyle; and (6) encourage the patient to quit smoking and maintain a tobacco-free lifestyle.¹¹² Patient education during the acute-phase cardiac rehabilitation should be focused on instructing the patient on how to deal with emergency situations and encouraging secondary prevention activities.

6. Points for Further Consideration

The widespread use of percutaneous coronary intervention (PCI) in patients with AMI has decreased the duration of hospitalization and allowed early return to society. Exercise training, which exerts multifaceted effects on physical and mental health, should be included as a standard part of the treatment of AMI.⁵⁹

Although there is discussion on the effect of β -blocker therapy on the response to exercise training after MI, mean changes in exercise capacity were not significantly different between post-MI patients receiving and not receiving β -blockers during cardiac rehabilitation program.¹¹³ Also, after AMI, the effects of exercise training and β -blockers on heart rate variability are not redundant.¹¹⁴

Although the benefits of exercise training in post-MI patients have been demonstrated, the use of cardiac rehabilitation is quite limited, which contrasts with the widespread use of PCI in the treatment of MI. In a survey in 2009 in Japan,¹¹⁰ only 21% of post-MI patients participated in outpatient cardiac rehabilitation programs after discharge (Figure 3).¹¹⁵ The number of institutions providing outpatient cardiac rehabilitation programs must be increased substantially to establish cardiac rehabilitation as an essential step for post-MI patients, for whom in-hospital treatment of AMI has become shorter than ever.¹¹⁶

2. Patients After Cardiac Surgery

Class I

1. Exercise training is recommended for patients after CABG because it is effective in improving symptoms and exercise capacity, and in controlling coronary risk factors. (Level of

Evidence: A)

2. Exercise training is recommended for patients after valve surgery, and is prescribed to improve symptoms and exercise capacity. (Level of Evidence: A)

Class IIa

1. It is appropriate to encourage patients to start ambulation as soon as possible after cardiac surgery. (Level of Evidence: B)
2. Patients should be carefully observed for occurrence of dysphagia after cardiac surgery. (Level of Evidence: B)
3. Unnecessary use of chest straps or excessive restriction of body movement that limits chest wall motion may delay the recovery of exercise capacity and increase the occurrence of complications. (Level of Evidence: C)
4. If not contraindicated, it is appropriate to conduct exercise training in all patients after cardiac surgery to improve exercise capacity and QOL as well as to decrease the incidence of cardiac events. The use of exercise training for patients with cardiac dysfunction or musculoskeletal disorder should be considered individually according to the pathophysiological conditions. (Level of Evidence: B)

Class IIb

1. The use of an incentive spirometer should be considered to prevent the occurrence of respiratory complications after cardiac surgery. (Level of Evidence: B)

1. Phase I (Acute Phase)

(1) Goals of Acute Phase Rehabilitation

Excessive bed rest after cardiac surgery may cause physical deconditioning and induce various complications. It is thus important during acute-phase rehabilitation after cardiac surgery that patients should be treated to stabilize hemodynamics and are encouraged to begin ambulation and return to their previous level of physical activity without delay.

(2) Rehabilitation Schedules (Tables 18, 19, 20)

Recently, the advancement of minimally invasive surgery and postsurgical management has made it possible to satisfy the criteria for postoperative ambulation, and thereby patients may leave the bed earlier and progress through cardiac rehabilita-

Table 18. Criteria for Ambulation After Cardiac Surgery

Ambulation should be encouraged when the patient does not meet any of the following criteria:

1. The patient has low-output syndrome, and
 - 1) is using life support devices such as a ventilator, IABP or PCPS;
 - 2) is receiving cardiotonics such as noradrenaline and catecholamines at high doses;
 - 3) has a systolic blood pressure of ≤ 80 – 90 mmHg (even under the treatment with cardiotonics);
 - 4) has cold extremities and cyanosis;
 - 5) has metabolic acidosis; or
 - 6) has a urine output of ≤ 0.5 – 1.0 mL/kg/hr for ≥ 2 hours
2. is using a Swan-Ganz catheter
3. has a resting heart rate of ≥ 120 bpm
4. has variable blood pressure (a change in body posture causes hypotension)
5. has hemodynamically unstable arrhythmia (e.g., newly developed atrial fibrillation, and Lown's grade $> IVb$ or severer PVCs)
6. has dyspnea or tachypnea at rest (respiratory rate > 30 /min); or
7. has bleeding tendency after surgery.

IABP, intra-aortic balloon pumping; PCPS, percutaneous cardiopulmonary support; PVCs, premature ventricular contractions.

Table 19. A Sample Rehabilitation Program for Patients After Cardiac Surgery (Based on Programs Used in Several Cardiovascular Hospitals in Japan)

Stage	Date	Contents	Rehabilitation in the ward	Excretion	Others
0	/	Active/passive movement of arms/legs, supported sitting, and respiratory training	Active movement of arms/legs, and respiratory training	On the bed	Observe for dysphagia
I	/	Sitting on the edge of the bed	Sitting on the edge of the bed 10 min×____ times	On the bed	
II	/	Standing/stepping (body weight measurement)	Standing/stepping×____ times	Bed pan	
III	/	Walking in the room	Walking in the room×____ times	Allow using a bedside commode	Allow free walking in the room
IV-1	/	Walking in the ward (100 m)	100 m walking×____ times	Allow using the toilet in the ward	Allow free walking in the ward
IV-2	/	Walking in the ward (200~500 m)	Walking in the ward (200~500 m)×____ times	Allow using the toilet in the hospital	Allow free walking in the hospital, and conduct an exercise stress test
V	/	Stair stepping (1 floor)	Exercise in the exercise room		Exercise training mainly with aerobics

Table 20. Criteria for Evaluating the Results of Exercise Stress Tests (Criteria for Moving to the Next Level of Exercise Training)**Exercise training does not induce**

1. Chest pain, severe shortness of breath, severe fatigue (Borg scale of >13), dizziness, lightheadedness, or leg pain;
2. Cyanosis, facial pallor, or cold sweat (objectively);
3. Tachypnea (>30/min);
4. Atrial fibrillation or an increase in the incidence of arrhythmias;
5. Ischemic ECG changes;
6. Excessive changes in blood pressure;
7. An increase in heart rate by ≥ 30 bpm; or
8. A decrease in oxygen saturation to $\leq 90\%$.

tion faster.¹¹⁷

In cardiac rehabilitation after cardiac surgery, the increment of load is larger than that seen after AMI. It is considered fine to prolong walking distance or exercise intensity on the day of surgery as possible provided that satisfy the criteria. Recently, the wide-spread use of minimally invasive surgery and the advancement of cardioplegia and postoperative management have enabled fast-track rehabilitation programs in which the patient is weaned from the ventilator on the day of surgery, and starts standing and walking on postoperative day 1 with a goal of progressing to ambulation in the ward by postoperative day 4~5.

(3) Dysphagia and Respiratory Complications

1) Dysphagia

Because dysphagia may cause aspiration pneumonia, the screening, evaluation, and treatment of dysphagia after cardiac surgery are important. It has been reported that dysphagia develops in 3~51% of patients undergoing cardiac surgery,^{118,119} and was associated with risk factors such as the presence of prolonged postoperative heart failure and the use of ventilators for 48 hours or longer.

2) Respiratory Physiotherapy

After open heart surgery, the movement of chest wall is restricted, both physically and mentally due to postoperative pain from sternotomy, and respiratory function declines. Although

incentive spirometers have been used after cardiac surgery to prevent respiratory complications, negative results have been reported.¹²⁰⁻¹²²

3) Median Sternotomy and Use of Chest Straps

In countries other than Japan, “chest straps” are not used for patients after cardiac surgery. Unnecessary use of chest straps or excessive restriction of body movement that limits chest wall motion may delay the recovery of exercise capacity and increase the occurrence of complications.¹²³

2. Phase II (Recovery Phase) and Later Phases

(1) Effects of Exercise Training

In addition to the benefits described in Chapter II-1 “Physical Effects”, exercise training after open heart surgery may increase graft patency. Cardiac rehabilitation also decreases re-hospitalization rate and associated healthcare costs after open heart surgery.

(2) Methods of Exercise Training

The patient in the acute phase after open heart surgery should undergo an exercise stress test (cardiopulmonary exercise test [CPX] whenever possible) on postoperative day 4~10 when he/she is able to walk for 30~100 m, and has started aerobic exercise using a cycle ergometer or treadmill. It should be confirmed that the patient (1) is afebrile and shows an improvement in inflammatory response, (2) does not have a large

volume of pericardial or pleural effusion, (3) has no newly developed atrial fibrillation/flutter, and (4) has a hemoglobin level of ≥ 8 g/dL with a tendency towards improvement.

Exercise at an AT level is preferable. When CPX is not feasible, the target heart rate during exercise training may be calculated using the Karvonen formula and the patient's actual maximum heart rate with a k coefficient of 0.3–0.6. However, heart rate response is often blunted immediately after cardiac surgery, and the target heart rate must be selected carefully.

Although resistance training is effective, patients should avoid strenuous upper extremity exercises during the first 3 months after open heart surgery. Patients may start range of motion (ROM) exercise early after cardiac surgery.¹²⁴

(3) Outpatient Rehabilitation Programs

Because cardiac rehabilitation should be continued for life, exercise training after discharge is important. Since the duration of hospitalization after cardiac surgery has become increasingly shorter, healthcare professionals should assess the patient's lifestyle in the early stage of hospitalization and instruct him or her on how to continue exercise training after discharge to ensure sufficient patient education by the time of discharge. In Japan, because many patients are discharged home after cardiac surgery rather than to a cardiac rehabilitation center, healthcare professionals should instruct patients and their family members on how to continue exercise training and disease management in the home. It has been reported that multi-faceted, comprehensive programs improved the 10-year, event-free survival.¹²⁵

3. Characteristics of Women Undergoing CABG and the Results of Cardiac Rehabilitation

Women undergoing CABG are generally older than similar male patients, often have concomitant hypertension and/or diabetes with advanced cardiovascular disease, and have a small body surface area with small coronary vessels. Due to the infrequent use of internal thoracic artery grafting, the operative mortality rate and 30-day mortality rate are higher in women than men undergoing CABG.^{126–134} Off-pump CABG has been increasingly used in Japan, and the results of female patients are particularly favorable. However, few studies have investigated gender difference in the effects of cardiac rehabilitation after cardiac surgery.¹³⁵

3. Intervention for Angina Pectoris/Coronary Artery Diseases

Class I

1. Cardiac rehabilitation for the purpose of improving prognosis is recommended for patients with CAD. (**Level of Evidence: A**)

Class IIa

1. Exercise training or cardiac rehabilitation is appropriate to improve anginal symptoms. (**Level of Evidence: B**)
2. Cardiac rehabilitation is appropriate to prevent the progression of coronary lesions and improve myocardial perfusion. (**Level of Evidence: B**)
3. Exercise training is appropriate for patients after PCI because it is beneficial in preventing restenosis and cardiovascular events. (**Level of Evidence: B**)

Class IIa'

1. It is appropriate to perform an exercise stress test and begin exercise training 1–3 days after PCI. (**Level of Evidence: B**)

Although the scientific evidence is weak (**Level of Evidence: B**), it has been reported that exercise training improves anginal symptoms, prevents the progression of coronary lesions, and increases myocardial perfusion in patients with CAD.^{89,136}

Although cardiac rehabilitation is theoretically indicated for patients after PCI,^{137,138} there is no Class I evidence supporting the benefits of exercise training in this patient population.^{106,139} Because the number of patients undergoing PCI is increasing, and patients have a risk of subacute stent thrombosis in the early period after stenting, it is important to establish criteria for early implementation of comprehensive programs centering on exercise training. In Japan, reports on the effect of exercise training in patients after PCI have been published, and Class IIa' evidence is becoming available (**Level of Evidence: B**).^{140–143} Although no large-scale randomized studies have been conducted, no safety concerns have been reported.

1. Exercise Training

Exercise training for patients with angina pectoris should be implemented according to Chapter III “General Rules of Exercise Prescriptions”. It is desirable that exercise training be prescribed according to the results of CPX (Table 13). The

Table 21. Exercise Intensity for Patients With Angina Pectoris and Patients After Coronary Intervention

How to set goals

1. 40–70% of the peak $\dot{V}O_2$ or AT level
2. Karvonen formula

$$[(\text{Expected maximum heart rate (220-age) or maximum heart rate-resting heart rate}) \times (0.4-0.6)] + \text{resting heart rate}$$
3. Ratings of perceived exertion: Borg scale 11–13

About 80% of the exercise intensity that causes ischemic symptoms

- Ischemic findings indicating anginal symptoms
- Ischemic ST changes (horizontal, downsloping or upsloping [ST segment depression ≥ 0.2 mV at 80 msec from J point], or ST elevation
 - Arrhythmias due to ischemia
 - An insufficient increase or a decrease in blood pressure due to ischemia

AT, anaerobic threshold; peak $\dot{V}O_2$, peak oxygen uptake.

intensity and frequency of exercise training should be prescribed carefully to ensure the safety of exercise training. Because patients may have mild myocardial ischemia after PCI that does not cause symptoms and ischemic ST changes, physicians should carefully evaluate the severity of residual coronary lesions of each patient. Patients with stents should drink water during training sessions and take their medication as they are at risk of thrombosis not only immediately after but also for several years after receiving their stents.¹⁴⁴

There are no established criteria for the exercise prescription for patients with angina pectoris. However, considering the fact that patients undergoing elective stenting return to their normal ADLs after treatment, patients may be able to start exercise training with a maximum workload of 6–7 metabolic equivalents (METs) immediately after receiving their stents (Table 21).

2. Instruction and Management of Outpatient Exercise Training Sessions

Outpatient exercise training for patients after PCI should be performed according to the secondary prevention programs for patients after MI (Section IV-1 “Myocardial Infarction”). Secondary prevention in patients after PCI should include appropriate types and doses of drugs that achieve the goals described in the relevant guidelines.¹⁴⁵ In Japan, elderly women with CAD, a situation that is becoming increasingly common, generally respond well to PCI but often have more coronary risk factors than do their male counterparts. Women should therefore be followed up carefully after PCI.

4. Arrhythmias

Some types of arrhythmias are induced by exercise, while other types of arrhythmias are prevented by exercise. Physicians should consider both types of arrhythmias when discussing the relationship between arrhythmias and exercise. However, few RCTs have fully described this relationship.

Class I

1. Exercise training programs which can prevent sudden death in patients with MI are recommended, but only when these patients do not meet the criteria for terminating exercise training. (Level of Evidence: A)

Class IIa'

1. Physicians should consider prescribing exercise training for patients with premature ventricular contraction (PVC) who do not meet the criteria for terminating exercise training because exercise training is beneficial for QOL in patients with atrial fibrillation, those with pacemakers, and

those with implantable cardioverter defibrillators (ICDs). (Level of Evidence: C)

Class III

1. Patients with ventricular arrhythmia who meet criteria for terminating exercise training should avoid exercise training.

1. Exercise and Arrhythmias¹⁴⁶

Arrhythmias may be induced by a combination of various factors including emotional stress, anxiety, smoking, drinking, taking caffeine, ingestion of diuretics or digitalis, or insomnia.

2. Effects of Exercise Training on Arrhythmias

(1) Ventricular Arrhythmias (Table 22)

It is believed that exercise training decreases the incidence of ventricular arrhythmias via the mechanisms listed in Table 22.

(2) Atrial Fibrillation

Atrial fibrillation impairs exercise capacity.¹⁴⁷ The mechanisms of the impaired exercise capacity are thought to be decreased cardiac output by diminished left ventricular filling pressure caused by loss of atrial contraction, tachycardia, or irregular rhythms, or reduced vasodilation responses to nitric oxide (NO) during exercise.¹⁴⁸ Palpitations and heart failure symptoms caused by atrial fibrillation can deteriorate QOL.

Exercise training improves the impaired exercise capacity and deterioration of QOL in patients with atrial fibrillation. Although currently available evidence is limited, exercise training is expected to be effective in patients with chronic atrial fibrillation, and is highly recommended for this patient population.^{149–152}

Although currently available evidence is also limited regarding the effect of exercise training in patients with atrial fibrillation after cardiac surgery, patients undergoing cardiac surgery should begin cardiac rehabilitation programs before surgery and restart the programs immediately after surgery to prevent the occurrence of atrial fibrillation after cardiac surgery.¹⁵³

(3) Pacemaker

Exercise capacity is impaired in patients who depend on pacemakers, but it has been reported that exercise capacity improves after exercise training with optimal pacing rate settings.^{154,155} To achieve the goal of cardiac rehabilitation, i.e., obtaining a significant improvement in exercise capacity,¹⁵⁶ physicians should not only prescribe appropriate exercise training programs but also adjust the pacing rate appropriately on the basis of exercise stress test. The reader should refer to Chapter IV-5-3-1 “Patients with ICD or CRT-D” for exercise training in patients with cardiac resynchronization therapy (CRT) or ICDs.

Table 22. Mechanisms of Decreased Incidence of Ventricular Arrhythmia by Exercise Training

1. An increase in arrhythmic threshold through improvement of myocardial ischemia
2. Decreased sympathetic nervous activity and decreased blood catecholamine levels
3. Increased parasympathetic nervous activity
4. Decreased sensitivity of β -receptors
5. Improvement of cardiac function and cardiomegaly
6. Decrease in overdrive suppression
7. Improvement in energy metabolism system including lipid metabolism
8. Alleviation of mental stress

3. Practice of Exercise Training in Patients With Arrhythmias

(1) Ventricular Arrhythmias

1) Exercise Stress Test

Figure 4 shows a flowchart of how to introduce exercise training. Before beginning exercise training, patients must undergo an exercise stress test to assess their exercise capacity and the severity of ventricular arrhythmias. When ventricular arrhythmias meets the criteria for terminating exercise training before the patient has achieved the AT level during the exercise stress test, the patient should receive appropriate treatments (i.e., drug treatment, ablation, and/or treatment of causes of arrhythmias) to control the ventricular arrhythmias prior to introducing exercise training.

2) Exercise Prescription

Patients who have no cardiac dysfunction and have not shown exacerbation of arrhythmia during exercise stress test should begin training at a moderate intensity (refer to Chapter IV-5 "Acute and Chronic Heart Failure" for exercise training in patients with cardiac dysfunction).

3) After Introducing of Exercise Training Programs

When arrhythmia that meets the criteria for terminating exercise training after the introducing of exercise training program, physicians should consider whether the episode was caused by the high intensity of exercise training or represents an exacerbation of arrhythmia. When arrhythmia meets the criteria for terminating exercise training even after shortening the duration of each exercise session or decreasing the intensity of exercise, physicians should identify the cause of exacerbation and treat the arrhythmia.

(2) Atrial Fibrillation (Figure 5)

1) Exercise Stress Test

Because of no evidence for optimal heart rates at rest and during exercise, patients should be individually assessed to determine whether their heart rates are adequately controlled. Because only a small number of Japanese patients with atrial fibrillation have achieved the goal of adequate rate control as recommended in the guidelines for the management of patients with atrial fibrillation published by the American College of Cardiology Foundation (ACCF)/AHA before the introducing of exercise training, physicians should consider an exercise stress test for patients in whom heart failure is controlled (see Chapter IV-5 "Acute and Chronic Heart Failure") and heart rate at rest is less than 110bpm. The feasibility of exercise training should be determined on the basis of the change in heart rate, symptoms, duration of exercise, and peak METs during exercise stress test, among other findings. Physicians may use the heart rate variability index $[HRVI = \{(\text{maximum heart rate}) - (\text{resting heart rate})\} / (\text{duration of exercise})]$ to define adequate rate control as a HRVI of ≤ 10 bpm/min.

2) Exercise Prescription

It is difficult to use heart rate as a determinant of exercise intensity for patients with atrial fibrillation. On a CPX, exercise intensity for patients with atrial fibrillation should be determined by calculating the walking speed using the intensity or METs at the AT level. On a treadmill test is conducted, the target exercise intensity should be determined at 40~60% and 20~40% of the METs at the maximum workload for patients who need moderate and light intensity exercise programs, respectively. When patients cannot undergo an exercise stress test, physicians should prescribe exercise intensity using Borg scale for ratings of perceived exertion.¹⁰⁴ Patients without car-

diac dysfunction should begin exercise at a moderate intensity. In some patients with atrial fibrillation, oxygen uptake and pulse rate at the AT level are higher than 40~60% of those the maximum workload, and moderate intensity exercise may not be sufficient to reach the AT level. In such patients, physicians should consider intensifying the exercise when the prescribed exercise is considered insufficient on the basis of blood pressure, pulse rate, and symptoms after introducing exercise training programs.

3) After Introducing of Exercise Training Programs

Patients with a resting heart rate of >110 bpm should not attend the session for the day, or consider switching to less intense or shorter session. When signs and symptoms of heart failure (e.g., dyspnea, edema, and anorexia for symptoms, and increased body weight ≥ 2 kg within one week, decreases in SpO₂ [percutaneous arterial oxygen saturation] at rest and immediately after exercise as compared with baseline, pulmonary congestion and worsening of pleural effusion on X-ray for

signs) develop after the introducing of exercise training, exercise intensity should be decreased and treatment of heart rhythm disorder and heart failure should be given.

(3) Pacemakers (Figures 6 and 7)

1) Exercise Stress Test

Exercise stress test must be performed in patients with pacemakers before introducing exercise training programs not only to assess exercise capacity and determine exercise intensity but also to evaluate the heart rate response of the pacemaker and the appropriateness of pacemaker setting.

2) Exercise Prescription

Exercise intensity for patients with sick sinus syndrome who require pacemakers may be calculated on the basis of the results of a treadmill test or CPX when the pacemaker uses physiological sensors to control pacing rate. This should be calculated using METs, the target heart rate calculated using the Karvonen formula, or the Borg scale on a treadmill test

when the pacemaker uses nonphysiological sensors. Exercise intensity for patients without cardiac dysfunction should be moderate. Because an excessively high target heart rate may

exacerbate heart failure or cause myocardial ischemia, physicians should monitor patients carefully.

Table 23. Criteria for Terminating Exercise Training (Lown's Grade 2 or Greater Ventricular Arrhythmia)

1. Ventricular tachycardia (triplets or more)
2. R on T premature ventricular contractions
3. Frequent monofocal premature ventricular contractions ($\geq 30\%$)
4. Frequent multifocal premature ventricular contractions ($\geq 30\%$)
5. Couplets (≥ 2 times/minute)

Source: American College of Sports Medicine. ACSM's Guidelines for Exercise Testing and Prescription, 6th edn. Philadelphia: Lippincott Williams & Wilkins; 2000.¹⁵⁷

3) After Introducing of Exercise Training Programs

During each exercise session, the heart rate response should be assessed using an ECG monitor. The patient should be carefully observed for whether an increase in heart rate triggers the development of myocardial ischemia or an exacerbation of heart failure.

4. Criteria for Terminating Exercise Training

The American College of Sports Medicine (ACSM) recommends that exercise training should be terminated in patients with Lown's grade 2 or greater ventricular arrhythmia (Table 23).¹⁵⁷

The criteria for terminating exercise training may differ whether exercise training is performed supervised or non-supervised. Physicians should also consider the recurrence of ventricular arrhythmias and the occurrence of specific types of PVC that may lead to sudden death.

5. Cardiac Events During Exercise

Mead et al. have reported that ventricular fibrillation during exercise training developed at an average of one per 6,000 person-hours of supervised exercise training.¹⁵⁸ Haskel et al. have reported that among 748,133 person-hours of exercise training conducted in 22 institutions, 10 cases of fatal cardiac events and 37 cases of non-fatal cardiac events developed during training sessions.¹⁵⁹ These findings indicated that the incidence of cardiac events during exercise training is low.

In Japan, there have been no cases of cardiac events caused by arrhythmias during exercise training in a study in which a total of 88,373 person-hours of supervised exercise training sessions were analyzed. Exercise training is considered safe.¹⁶⁰

In a survey conducted in an inpatient cardiac rehabilitation center in Italy to evaluate the incidence of cardiac arrhythmias during exercise in patients after CABG surgery, cardiac arrhythmias were 33.5% and were more frequent in patients with hypertension, diabetes, and dyslipidemia, compared with the rate in patients free from these diseases. The incidence of arrhythmias was significantly higher both in patients older than 70 years as compared with the rate in younger patients, and in patients who discontinued amiodarone as compared with those who did not interrupt the drug treatment.¹⁶¹ In a retrospective survey in Japan, the incidence of postoperative arrhythmia clearly related to exercise training was 0.92% in 1,293 patients after cardiac surgery.¹⁶²

6. Summary

There have been only a limited number of studies providing evidence on the effect of exercise training on arrhythmia and the risk of arrhythmia during exercise training. Patients who may develop arrhythmia during exercise should perform exercise sessions under ECG monitoring, and should conform to the criteria for terminating exercise training. However, exercise training is expected to be effective in the treatment of

ventricular arrhythmias, and further studies of the effect of exercise training on arrhythmias should be conducted.

5. Acute and Chronic Heart Failure

1. Cardiac Rehabilitation in Patients With Acute Heart Failure

Class I

1. An educational program on the prevention of heart failure recurrence and the enhancement of self-management is recommended to implement for all patients with acute heart failure. (**Level of Evidence: C**)

Class IIa

1. It is appropriate that all patients with acute heart failure participate in cardiac rehabilitation programs when the patients' condition are stabilized. (**Level of Evidence: C**)

(1) Significance of Cardiac Rehabilitation in Patients With Acute Heart Failure

Cardiac rehabilitation in patients with acute heart failure is conducted to 1) prevent adverse effects of excessive bed rest (e.g., physical/mental deconditioning, bedsores, and pulmonary embolism) by promoting early ambulation; 2) design, share, and implement plans to ensure prompt and safe discharge and returning to work; 3) improve the QOL of patients by improving their exercise capacity; and 4) prevent recurrent heart failure and rehospitalization through patient education and disease management. It is also important to motivate patients to participate in and continue cardiac rehabilitation programs after discharge.

(2) Physical Therapy and Exercise Training for Patients With Acute Heart Failure

Low-intensity physical therapy and exercise training are feasible for patients with acute heart failure who are hemodynamically stable and asymptomatic at rest even when they are receiving intravenous infusion. Patients are recommended to perform bending exercise of limbs, low-intensity resistance training on the bed, and standing position practice and tiptoeing on the bedside floor.

(3) Mental Support and Counseling for Patients With Acute Heart Failure

Patients with acute heart failure are severely anxious and mentally unstable. Mental support is thus important during the acute phase of acute heart failure to relieve mental pain and improve QOL during hospitalization. Table 24 lists methods for providing mental support. Healthcare professionals should carefully monitor patients for anxiety and depressive state, provide mental counseling promptly when such symptoms occur, and consider drug treatment and cognitive behavioral therapy when-

Table 24. Mental Support for Patients With Acute-Phase Heart Failure

1. Secure sufficient time to meet family members from an early phase of treatment.
2. Listen to the patient.
3. Explain the purpose and methods of examinations and treatments in advance to reassure the patient.
4. Talk to the patient to facilitate his or her expression of worries and questions.
5. Ensure that the patient has a sufficient length of sleep.
6. Encourage the patient to get refreshed to prevent excessive stress due to limited activities and visits.
7. Explain the schedule of examinations, treatment, and rehabilitation to provide the patient with information for future planning.
8. Suspect restlessness or CCU psychosis syndrome when the patient is uneasiness or insomnia, and consider preventive measures.

CCU, coronary care unit.

Table 25. Effects of Exercise Training in Patients With Heart Failure

1. Exercise capacity: improvement
2. Effects on the heart
 - a) Left ventricular function: No change or slight improvement in LVEF at rest, increase in the increment of cardiac output during exercise, and improvement in left ventricular early diastolic function
 - b) Coronary circulation: Improvement in coronary endothelial function, improvement in myocardial perfusion during exercise, and increase in coronary collateral flow
 - c) Left ventricular remodeling: Prevention (or inhibition) of progression, decrease in BNP
3. Peripheral effects
 - a) Skeletal muscle: Increase in muscle mass/strength, improvement in aerobic metabolism, and increase in expression of antioxidant enzymes
 - b) Respiratory muscles: Improvement in respiratory muscle function
 - c) Vascular endothelium: Improvement in endothelium-dependent vasodilation responses, and increase in expression of eNOS
4. Neurohumoral factors
 - a) Autonomic nervous system function: Inhibition of sympathetic nervous activity, increase in parasympathetic activation, and improvement in heart rate variability
 - b) Ventilatory response: Improvement in ventilatory response and CO₂ sensitivity of the respiratory center
 - c) Inflammatory reactions: Decreases in inflammatory cytokines (TNF- α) and CRP
5. QOL: Improvement in health-related QOL
6. Long-term prognosis: Decrease in hospitalizations due to heart failure, increase in event-free survival, and decrease in total mortality (meta-analyses)

BNP, brain natriuretic peptide; CRP, C-reactive protein; eNOS, endothelial nitric oxide synthase; LVEF, left ventricular ejection fraction; TNF, tumor necrosis factor; QOL, quality of life.

ever necessary.

(4) Patient Education for Patients With Acute Heart Failure

Patient education on how to manage heart failure and prevent rehospitalization should be performed from the early phase of hospitalization. Patients should be instructed to (1) measure, record, and manage body weight; (2) become aware of recurrence of heart failure; (3) maintain compliance to drug treatment; (4) limit salt intake; (5) limit alcohol intake and quit smoking; (6) continue appropriate exercise training. It is desirable that patients begin cardiac rehabilitation programs after stabilization of heart failure symptoms during hospitalization, and should shift to outpatient cardiac rehabilitation programs after discharge (see Chapter IV-5-2-4 “Cardiac Rehabilitation and Disease Management Programs in Chronic Heart Failure”).

2. Cardiac Rehabilitation in Chronic Heart Failure

Class I

1. It is recommended that chronic heart failure patients with impaired exercise capacity undergo exercise training aiming to improve symptoms and exercise capacity. **(Level of Evidence: A)**

Class IIa

1. Exercise training aiming to improve exercise capacity and QOL and to decrease cardiac events is an appropriate intervention for all chronic heart failure patients with reduced systolic function. **(Level of Evidence: B)**
2. Exercise training aiming to improve exercise capacity is an appropriate intervention for diastolic heart failure patients with impaired exercise capacity. **(Level of Evidence: B)**
3. Exercise training including low-intensity resistance training that is aiming to improve exercise capacity is an appropriate intervention for chronic heart failure patients with reduced muscle strength. **(Level of Evidence: C)**

(1) Effects of Exercise Training in Patients With Chronic Heart Failure

By the 1970s, bed rest had been recommended for patients with heart failure. Since the 1990s, researchers have reported that exercise training for patients with stable chronic heart failure is beneficial in improving exercise capacity,^{4,21,30,163–171} QOL^{4,13,163,169,172} and long-term prognosis,^{4,173} and so on (Table 25). In the HF-ACTION study in which 2,331 patients with stable chronic heart failure randomly received either drug treatment alone or drug treatment plus exercise training, since adherence to exercise training was low, exercise capacity,

Table 26. Contraindications for Exercise Training in Patients With Heart Failure**I. Absolute contraindications**

1. Exacerbation of heart failure symptoms (e.g., dyspnea, easy fatigability) during the last week
2. Unstable angina or low-threshold myocardial ischemia that is induced by slow walking on a flat surface (2 METs)
3. Severe valvular heart disease indicated for surgery, especially aortic stenosis
4. Severe left ventricular outflow tract obstruction (hypertrophic obstructive cardiomyopathy)
5. Untreated severe exercise-induced arrhythmia (ventricular fibrillation, sustained ventricular tachycardia)
6. Active myocarditis
7. Acute systemic disease or fever
8. Other diseases in which exercise is contraindicated (moderate or severe aortic aneurysm, severe hypertension, thrombophlebitis, embolism that developed in the last 2 weeks, and serious organ diseases)

II. Relative contraindications

1. NYHA classification of Class IV heart failure or heart failure requiring intravenous cardiotonics
2. Heart failure with an increase in body weight by ≥ 2 kg during the last week
3. Exercise-induced decrease in systolic blood pressure
4. Moderate left ventricular outflow tract obstruction
5. Exercise-induced moderate arrhythmia (e.g., nonsustained ventricular tachycardia, tachycardiac atrial fibrillation)
6. Advanced atrioventricular block
7. Exacerbation of exercise-induced symptoms (e.g., fatigue, dizziness, excessive sweating, dyspnea)

III. Not contraindicated

1. Elderly patients
2. Decreased LVEF
3. Heart failure during the use of LVADs
4. Use of ICDs

ICDs, implantable cardioverter defibrillators; LVADs, left ventricular assist devices; LVEF, left ventricular ejection fraction; METs, metabolic equivalents; NYHA, New York Heart Association.

QOL and long-term prognosis did not improve as expected.¹⁷⁴ A meta-analysis in 2010 indicated that exercise training does not decrease total mortality or total hospital admission in patients with chronic heart failure, but does decrease hospitalization due to heart failure and improves HRQOL.¹⁷²

Exercise training is effective in patients with chronic heart failure regardless of sex,¹⁷⁵ the type of underlying disease (ischemic or non-ischemic disease),^{7,176} use of β -blockers,^{177,178} left ventricular function,^{179,180} New York Heart Association (NYHA) classification (Class II or III).^{174,181,182} It also has been indicated in Japan that exercise training improves exercise capacity in Japanese patients with diastolic heart failure or severe cardiac dysfunction that is characterized by an LVEF of $<25\%$.¹⁸² It has been reported that exercise training helps improve exercise capacity, relieve anxiety and depression, and improve QOL in patients with ICDs or cardiac resynchronization therapy defibrillators (CRT-Ds).

(2) Indications, Contraindications, and Safety of Exercise Training in Patients With Chronic Heart Failure

1) Indications

All patients with chronic heart failure must be assessed carefully to determine whether exercise training is indicated.¹⁷⁶ Exercise training is indicated for patients with stable controlled chronic heart failure with a NYHA classification of Class II or III. Chronic heart failure is considered “stable” when the patient has not experienced symptoms (e.g., dyspnea, easy fatigability) and signs of heart failure (e.g., edema, pulmonary congestion) during the last week, and is considered “controlled” when the patient is euvoletic and does not have moderate or severe leg edema or pulmonary congestion.¹⁸³

2) Contraindications

Table 26 lists absolute and relative contraindications of exercise training in chronic heart failure. While systemic exercise training is not indicated for patients with NYHA classification of Class IV heart failure, some patients may be indicated for partial skeletal muscle training.¹⁸⁴ Although exercise training is generally contraindicated for patients who are elderly, have reduced LVEF, are using ventricular assist devices, or are using ICDs, these patients may be indicated for exercise training.

3) Safety

In a systematic review of studies of exercise training in patients with heart failure, there were no reports of deaths that were directly related to exercise during more than 60,000 patient-hours of exercise training.¹⁷³ The risk of cardiac events during exercise training is no higher than that seen in other cardiac rehabilitation programs in patients with heart failure. Cardiac events that may develop during exercise training include hypotension, arrhythmias, and exacerbation of heart failure.^{163,184} The incidence of cardiac events requiring hospitalization is lower in patients undergoing exercise training than in those not undergoing it.^{4,37,173,174} In a study of 111 patients with moderate or severe heart failure who participated in a 3-month exercise training program in Japan, the incidence of cardiac events (exacerbation of heart failure, hypotension, or arrhythmia) that necessitated termination and interruption of exercise training was 5% and 8%, respectively.¹⁸⁴

(3) Practice of Cardiac Rehabilitation and Exercise Training in Patients With Heart Failure

1) Basic Points of Cardiac Rehabilitation Programs for Patients With Heart Failure

Because the purpose of cardiac rehabilitation and exercise

Table 27. Exercise Prescriptions for Patients With Heart Failure**Type of exercise**

- Walking (begin with supervised indoor walking), cycle ergometer, light aerobics, low-intensity resistance training.
- Jogging, swimming, and vigorous aerobics are not recommended for patients with heart failure.

Exercise intensity**[Early phase]**

- Exercise should start with indoor walking at 50~80 m/min for 5~10 min or a cycle ergometer at 10~20 W for 5~10 min.
- The duration and intensity of exercise should be increased gradually over 1 month by observing signs/symptoms during exercise.
- Resting HR+30 bpm (resting HR+20 bpm for patients receiving β -blockers) may be set as a simple HR target.

[Goal in the stable phase]

- The target HR is set at 40~60% of the peak $\dot{V}O_2$ or at AT level.
- The target HR is set at 30~50% of HR reserve, or 50~70% of the maximum HR.
 - The target HR is calculated using the Karvonen formula $[(\text{maximum HR} - \text{resting HR}) \times k + \text{resting HR}]$, and is set at $k=0.4\sim0.5$ for mild heart failure (NYHA classification of Class I~II) and $k=0.3\sim0.4$ for moderate or severe heart failure (NYHA classification of Class III).
- Target RPE is set at Borg scale 11~13 (fairly light~somewhat hard).

Duration

- Training should begin with 5~10 min/session, 2 sessions a day, and increase gradually to 30~60 min/day (20~30 min/session, 2 sessions a day).

Frequency

- 3~5 days a week (The frequency may be increased to 3 days/week for patients with severe heart failure, and 5 days/week for those with mild heart failure.)
- Low-intensity resistance training may be added at a frequency of 2~3 days/week.

Precautions

- Exercise during the first month should be light in intensity, and physicians should watch the patient for exacerbations of heart failure.
- Programs should begin with supervised training, and should be continued with combination of supervised and non-supervised (home-based) exercise training programs during the stable phase.
- Changes in symptoms, body weight, and blood BNP levels should be observed carefully.

AT, anaerobic threshold; BNP, brain natriuretic peptide; HR, heart rate; peak $\dot{V}O_2$, peak oxygen uptake; RPE, ratings of perceived exertion.

Table 28. Findings Suggestive of Excessive Exercise Intensity

- Symptoms (continued malaise, fatigue that lasts into the following day, and increase in Borg scale by ≥ 2 in the same exercise)
- Tendency toward increased body weight (by ≥ 2 kg in one week)
- Tendency toward increased heart rate (by ≥ 10 bpm at rest or during the same exercise)
- Tendency toward increased BNP level (by ≥ 100 pg/mL as compared with the previous measurement)

BNP, brain natriuretic peptide.

Adopted from Goto Y. Cardiac rehabilitation as heart failure therapy. *Journal of the Japanese Association of Cardiac Rehabilitation (JJCR)* 2008; **13**: 273~277,¹⁸⁷ with modification.

training programs for patients with heart failure includes improving exercise capacity, improving QOL, preventing rehospitalization, and achieving a better long-term prognosis, programs must consist of (1) exercise training, (2) patient education, and (3) counseling. As patients with heart failure may vary in cause and severity, exercise training programs should be prescribed individually by physicians on the basis of clinical findings of the results of exercise stress test, and should be carefully implemented. Training programs should begin with supervised exercise training under ECG monitoring.^{99,176,185} After the safety of the prescribed program is confirmed, patients should begin non-supervised home-based exercise training programs.

2) Exercise Prescriptions for Patients With Heart Failure

Table 27 lists exercise prescriptions currently recommended for patients with heart failure.

Rhythmic aerobic exercises are commonly recommended. Patients with reduced muscle strength are expected to improve

exercise capacity when they perform both rhythmic aerobic exercises and low-intensity resistance training. When prescribing exercise intensity, physicians should consider not only current symptoms and exercise capacity data but also variable parameters of severity of heart failure and patients' characteristics such as left ventricular function, change of BNP levels, and drug treatment. Patients with a BNP level of ≥ 400 pg/mL should begin exercise training at an extremely low intensity, and should be carefully followed up for changes in their heart failure condition.^{184,186}

3) Considerations During Exercise Training in Heart Failure: Monitoring and Revising Exercise Prescriptions

To ensure the safety and efficacy of exercise training in heart failure, monitoring of patients and periodic revising of their exercise prescriptions are essential.

Table 28 lists findings that indicate exercise intensity is excessive during training.¹⁸⁷

Although transient exacerbation of heart failure such as body weight gain and exacerbated congestion may develop 1–2 weeks after the introducing of exercise training, these events may be treated by limiting water intake, temporally increasing the dose of diuretics, and temporally reducing the amount of exercise.¹⁸³ Patients who completed one-month training programs may shift to home-based (non-supervised) exercise training programs. However, it is desirable that patients with severe heart failure combine home-based programs with periodic (e.g. weekly) outpatient supervised exercise training programs to ensure the safety and compliance.¹⁸⁴

4) Efficacy Evaluation

The efficacy of exercise training should be evaluated at months 3 and 6 on the basis of clinical findings, exercise capacity, cardiac function and blood tests, among other measures. Healthcare professionals should provide the results of efficacy evaluation to patients and make them understand the benefits of exercise training to motivate them to continue their lifestyle management strategies. During the maintenance phase, that is defined month 6 and thereafter, healthcare professionals should encourage patients to continue exercise training and maintain a good condition.

5) Patient Education and Counseling

To accomplish successful exercise training, patients should fully understand how to manage chronic heart failure and acquire practical skills. Healthcare professionals should (1) provide correct knowledge about heart failure (e.g., pathophysiology, triggers and initial symptoms of exacerbation, coronary risk factors); (2) motivate patients to improve their lifestyle to prevent recurrence and inform them to ensure they take appropriate measures (e.g., comply with diet therapy, instruction on drug treatment, and learn self-pulse-taking procedures, how to prevent exacerbation of heart failure); and (3) instruct patients and their family members of the allowance of ADL. Ensuring daily body weight measurement is particularly important.

(4) Cardiac Rehabilitation and Disease Management Programs in Chronic Heart Failure

In Western countries, an increasing number of reports have described that disease management programs using multidisciplinary interventions including patient education, instruction, counseling, and follow-up after discharge improve QOL and save healthcare cost, and decrease rehospitalization.^{188–190} Disease management programs that cover from the acute to chronic phases of heart failure may be developed by ensuring smooth transition from clinical pathways in acute-phase heart failure to recovery-phase cardiac rehabilitation and home-based management programs in chronic stable heart failure. It is expected that outpatient cardiac rehabilitation programs will be established for long-term management of heart failure.

3. ICD, CRT-D and Sleep-Disordered Breathing

(1) Patients With ICD or CRT-D

Class I

1. Exercise training aiming to improve exercise capacity and QOL is recommended for heart failure patients treated with ICD. (**Level of Evidence: B**)
2. Exercise training aiming to further improve exercise capacity and QOL is recommended for heart failure patients treated with CRT. (**Level of Evidence: B**)

Class IIa

1. Exercise training aiming to further improve cardiac function is appropriate for heart failure patients treated with CRT. (**Level of Evidence: B**)

Patients with ICD or CRT-D often experience impaired exercise capacity caused by physical deconditioning due to prolonged bed rest, and a deterioration of their daily QOL due to a fear of the ICD shock. It is concerned that the increase in heart rate associated with exercise may trigger an inappropriate discharge of ICD, but studies have reported that exercise training in patients with ICD is as effective as in patients without ICD and does not cause inappropriate discharges.¹⁹¹ It also has been reported that exercise training improves not only exercise capacity but also endothelial function in patients with ICD,¹⁹² and that cardiac rehabilitation relieves anxiety and depression in patients with ICD as compared with findings for those not receiving cardiac rehabilitation.¹⁹³

Although high-level evidence is limited regarding the efficacy and safety of cardiac rehabilitation in patients with ICD, it has been indicated that supervised exercise training in patients with ICD may be conducted safely, and is as effective as that in those without ICD, and have a favorable psychological effect.

It has been well known that CRT devices improve cardiac function, exercise capacity, and QOL. Exercise training further improves exercise capacity in patients with CRT.¹⁹² In a randomized study in 52 men in chronic heart failure with ischemic cardiomyopathy who received an ICD with or without CRT (i.e., CRT-D or ICD), patients were randomized into 2 groups with and without a supervised exercise training program. The beneficial effects of exercise were especially great among patients with CRT-D. In a RCT to study the effect on exercise capacity of endurance training in addition to CRT in patients with chronic heart failure and dyssynchrony, the increase in peak $\dot{V}O_2$ and maximal workload (Wattmax) was significantly greater in trained versus untrained CRT patients.¹⁹⁴ In a recent randomized controlled study, patients were allocated into the exercise training or control group 3 months after CRT implantation. Three months after CRT implantation there were significant improvements in NYHA classification, peak $\dot{V}O_2$, exercise hemodynamics, and cardiac function. After randomization, the exercise group showed further significant improvements in functional, exercise hemodynamic, QOL measures, and skeletal muscle function compared with findings for the control group.¹⁹⁵ These findings indicate that the addition of cardiac rehabilitation to CRT further improves exercise capacity, cardiac function and other outcome measures in patients with chronic heart failure. To maximize the benefits of CRT, physicians should prescribe cardiac rehabilitation proactively at an appropriate time after CRT implantation.

(2) Patients With Sleep-Disordered Breathing Associated With Heart Failure

Class I

1. Exercise training aiming to improve exercise capacity and QOL is recommended for patients with sleep-disordered breathing (SDB) associated with heart failure. (**Level of Evidence: C**)

Class IIb

1. The use of non-invasive positive-pressure ventilation aiming to improve exercise capacity and physical functions may be considered for patients with central sleep apnea (CSA) associated with heart failure. (**Level of Evidence: C**)

- Nocturnal home oxygen therapy (HOT) aiming to improve exercise capacity and physical functions may be considered for patients with CSA associated with heart failure. **(Level of Evidence: C)**
- Cardiac rehabilitation may be considered to improve SDB in patients with heart failure. **(Level of Evidence: C)**

It is known that SDB often develops in patients with heart failure. SDB is classified into obstructive sleep apnea (OSA) due to airway obstruction and CSA due to loss of respiratory drive from the respiratory center. It is believed that CSA associated with heart failure and exertional oscillatory ventilation (EOV) that may develop during exercise in patients with heart failure share common pathophysiological characteristics.¹⁹⁶ It has also been reported that a combination of CSA and EOV has a prognostic value.¹⁹⁷

1) Improvement in Exercise Capacity With Treatment of Sleep-Disordered Breathing

It has been reported that treatment of SDB improves exercise capacity in patients with heart failure. For instance, adaptive servo-ventilation (ASV), the most effective treatment method for CSA with Cheyne-Stokes respiration (CSR-CSA), increases peak $\dot{V}O_2$, AT level, and 6-minute walking distance as compared with continuous positive airway pressure (CPAP)¹⁹⁸ and nocturnal HOT improves SDB as well as exercise outcome measures such as peak $\dot{V}O_2$ and AT level.¹⁹⁹ However, studies reporting such findings are not randomized control studies.

Studies have reported that cardiac rehabilitation improves SDB. In a study of 25 patients with heart failure complicated with SDB, cardiac rehabilitation improved exercise capacity and QOL in patients with and without SDB, and lessened the severity of OSA.²⁰⁰

Thus, studies suggest that cardiac rehabilitation may improve SDB. However data of RCTs are limited, and evidence is insufficient **(Class IIb)**.

4. New Treatment Methods and Cardiac Rehabilitation

(1) Surgical Treatment: Mitral Reconstructive Surgery Class IIa

- Cardiac rehabilitation is an appropriate intervention for patients who underwent mitral reconstructive surgery for the treatment of heart failure. **(Level of Evidence: C)**

Mitral reconstructive surgery is a surgical treatment option for patients with heart failure. Patients with ischemic heart failure often undergo CABG combined with mitral reconstructive surgery. It has been reported that LVEF increased by about $25 \pm 10\%$ and NYHA classification increased from 3.9 ± 0.3 to 2.0 ± 0.6 in patients successfully treated with the combination surgery.²⁰¹ However, studies indicate that successful surgery does not promptly improve cardiac function, and exercise capacity does not improve 6 months after the mitral reconstructive surgery alone.²⁰² Patients should undergo cardiac rehabilitation aiming to facilitate recovery from cardiac surgery and to improve chronic heart failure.

Exercise training in patients who underwent mitral reconstructive surgery should begin with resistance training that does not affect the sternum. Patients should begin exercise with leg training using a rubber tube or ball on the bed. When standing is allowed, patients should begin with standing on tiptoe on the bedside floor. After the bedside exercise, patients should follow exercise training programs for heart failure.

Safety analysis of patients who underwent mitral reconstructive surgery revealed that no patients experienced new onset

or recurrence of mitral regurgitation.²⁰³

(2) Waon Therapy

Class I

- Waon therapy is effective in patients with heart failure. **(Level of Evidence: C)**
- A combination of waon therapy and exercise training is effective. **(Level of Evidence: C)**

In waon therapy, a thermal therapy developed in Japan, patients stay in a far-infrared heating sauna at 60°C for 15 minutes to increase deep body temperature by 1.0–1.2°C, and are covered with thermal blankets to maintain body temperature for 30 minutes. After the session, patients take water to replenish water loss from sweating. Waon therapy with one session a day, 3–5 days a week for 2–6 weeks has been reported effective for increasing cardiac output,²⁰⁴ relieving symptoms, enhancing vascular endothelial cell function, activating autonomic nervous system, exerting a favorable effect on neuro-humoral factors, alleviating depressive state,²⁰⁵ and decreasing ventricular arrhythmia in patients with heart failure.²⁰⁶ It has been reported that a combination of exercise training and waon therapy improved exercise capacity in patients with chronic heart failure.²⁰⁷ It is expected that waon therapy may facilitate exercise training by improving heart failure and decrease arrhythmia.

5. Current Status and Challenges of Exercise Training Program

In Japan, chronic heart failure with (1) a LVEF of $\leq 40\%$ or (2) a blood BNP level of ≥ 80 pg/mL, or (3) a peak $\dot{V}O_2$ of $\leq 80\%$ of reference value was approved as an indication of cardiovascular rehabilitation in the medical service fee revision in April 2006.

Exercise training in chronic heart failure should be further investigated to (1) establish the criteria for selecting patients who might benefit; (2) establish optimal exercise prescriptions; (3) assess possible synergistic effects of combining exercise training with drug or device treatment; (4) evaluate the effects of exercise training on the prognosis of patients with heart failure in Japan; (5) establish measures to improve adherence to exercise training; and (6) design strategies to encourage exercise training in hospitals treating patients with heart failure.

6. Heart Transplant Recipients

Class I

None.

Class IIa

- It is appropriate to introduce exercise training early after heart transplantation aiming to improve exercise capacity. **(Level of Evidence: B)**

The cardiovascular response to exercise is influenced by the loss of autonomic control of heart rate after heart transplantation. Patients may also experience cardiac dysfunction due to donor-to-recipient graft size mismatch or rejection, adverse effects of immunosuppressants, severe deconditioning due to long-term heart failure or prolonged bed rest, and significant anxiety about the future, among others. Healthcare professionals should consider these points carefully before prescribing exercise training programs.

1. Efficacy of Exercise Training

Exercise training increases peak $\dot{V}O_2$ and decreases resting heart rate in heart transplant recipients.^{208–211} The efficacy of exercise training after heart transplantation has been demonstrated in RCTs.²¹²

2. Cardiac Rehabilitation Programs in Heart Transplant Recipients

Cardiac rehabilitation in heart transplant recipients consists of the acute, recovery, and maintenance phases.

During the acute phase, cardiac rehabilitation should begin as soon as possible after transplant surgery to avoid complications due to prolonged bed rest and alleviate mental stress.

During the recovery phase, rehabilitation programs that are usually prescribed for patients who underwent cardiac surgery and for those with heart failure should be introduced to improve exercise capacity, expand the ADL, decrease the incidence of mental disorders such as anxiety, depression, and loss of self-confidence, and promote returning to work with better physical and mental health. At the time of patient discharge, physicians in cardiac rehabilitation team should prescribe home-based exercise training programs for recipients and explain how to continue exercise after discharge, and provide instructions for ADL. Recipients should be encouraged to attend outpatient exercise training programs whenever possible.

During the maintenance phase, recipients should continue non-supervised home-based exercise training programs.

3. Rehabilitation in Patients With Left Ventricular Assist Devices

Because patients with LVADs or left ventricular assist system (LVAS), who have had heart failure for a long time before LVAD implantation often have severe deconditioning, it is important to help them efficiently recovery from disuse atrophy. Healthcare professionals must have extensive knowledge and understanding of LVADs and motor impairments because LVAD may increase the risk of cerebrovascular disorders resulting from thrombi in the blood pump or bleeding caused by anticoagulation therapy. Reports in and outside Japan indicate that cardiac rehabilitation including early ambulation is necessary for patients with stable hemodynamics after LVAD implantation, and that quantitative aerobic exercise training such as pedaling of cycle ergometer or treadmill walking should be conducted in addition to walking around the ward to promote the recovery of exercise capacity.^{213,214}

Because implantable LVADs have recently become covered by the NHI, the use of LVADs will be increasingly common as a measure to facilitate home-based treatment and returning to work. Cardiac rehabilitation will become more important in this patient population.^{215,216}

V Exercise Training in Children With Cardiac Diseases

Class I

None.

Class IIa'

1. It is appropriate to provide exercise training in children after surgery for congenital heart disease (CHD) as it effectively improves physical functions such as exercise capacity and stroke volume.

However, physicians should carefully assess the effects of exercise training, which may differ significantly among children after surgery for CHD. (**Level of Evidence: B**)

Exercise during childhood is effective not only in enhancing physical and mental development, maintaining health, and improving QOL but also in promoting the development of a lifelong active lifestyle, preventing obesity and dyslipidemia, and coping with stresses. It is believed that children with CHD should exercise within their limits.

Although a large number of reports have been published on the efficacy of exercise training in children after surgery for CHD, only a few reports have described the effects of exercise training and comprehensive programs in children with CHD before surgery.

1. Children After Surgery for Congenital Heart Disease

After surgery for CHD, children who have impaired exercise capacity and abnormal cardiovascular response during exercise should begin exercise training to (1) improve exercise capacity to allow them to exercise safely and improve QOL; (2) encourage them to participate in social and productive activities; and (3) motivate them to continue to exercise, there-

by modifying coronary risk factors such as hypertension, diabetes, and hyperlipidemia in the future.

Supervised exercise training is indicated for children with CHD without serious ventricular dysfunction or arrhythmias who cannot undergo further surgical treatment and have impaired exercise capacity. This category of children with CHD include those who have cardiac dysfunction after Rastelli operation, Mustard/Senning operation, or Fontan operation, and those after Glenn operation or Blalock-Taussig operation for whom no further operations are planned, and those who have pulmonary hypertension or arrhythmias after surgery. Children with complete recovery of cardiac function are also indicated for supervised exercise training when they have significantly impaired exercise capacity, feel strong anxiety about exercise, or have been under an unnecessarily strict limitation on exercises. CHD differs significantly between patients, and the cardiac function and cardiopulmonary responses during exercises may often differ even among children who have a similar type and severity of CHD and lesions remaining after surgery.

Safe exercise prescriptions are especially important for children with severe CHD. Physicians should carefully and comprehensively evaluate the characteristics of cardiopulmonary responses during exercise in each child before prescribing exercise training programs. Exercise intensity should be set according to the results of an exercise stress test and the condition and characteristics of the individual patient. Physicians should carefully consider the risk and history of significant ventricular dysfunction and arrhythmias. It should also be noted that the physical development and associated changes in physical activities after the introducing of exercise training may affect the evaluation of efficacy of training programs in children.

The efficacy of exercise training in children has been re-

ported in studies using programs consisting of 60-minute sessions including 20–30 minutes main exercise, 2–3 sessions/week, for 10–12 week. The intensity of the main exercise is generally set at 60–80% of the maximum heart rate. However, it is more desirable that children should begin their programs with an intensity of around the AT, be followed for changes over time in exercise capacity, and undergo a gradual increase towards more intense training for longer durations.

It is important to provide enjoyable and game-like exercise sessions to prevent dropout and motivate children to continue their exercise programs. Parents should also be encouraged to join exercise training programs to motivate the children to continue their programs, help the families establish active lifestyles, and improve QOL of the children and family members after completing the exercise training programs.^{217–219}

2. Children With Congenital Heart Disease Who Have Not Undergone Surgery

It is known that children with acyanotic CHD, except for those with severe disease, show exercise capacity similar to healthy children in treadmill exercise test. Exercise should be restricted in children with uncorrected aortic stenosis, mitral regurgitation, or aortic regurgitation.

Children with cyanotic CHD have hypoxemia that causes impaired exercise capacity and dyspnea with even the slightest activity, and limits spontaneous exertion. However, it has been

reported that exercise training may improve exercise capacity even in children with cyanotic CHD through increasing cardiopulmonary function and muscle strength. Because physical fitness does not improve in children with a less active lifestyle, children are recommended to perform exercises within their limits. However, it is unclear whether exercises within the patient's physical limitations may improve cardiopulmonary function or not.^{220,221}

3. Problems and Future Challenges in Exercise Training Programs for Children With Congenital Heart Disease

The efficacy of exercise training programs for children with CHD varies among hospitals. This difference is believed to be caused by the diversity in the children relating to their age, cardiac function, and exercise capacity at baseline, as well as the differences in type and severity of CHD and in lesions remaining after surgery. In addition, study protocols and exercise treatments will differ between hospitals. Further studies should be conducted to develop criteria for selecting children with CHD who are expected to respond favorably to exercise training, to investigate how to prescribe exercise training programs, to clarify mechanisms of the effect of exercise training on the cardiac function of children with CHD, and to develop optimal and effective exercise programs for children with severe CHD.²²²

VI Significance of Exercise Training in Elderly Patients With Cardiovascular Diseases

In the guidelines on secondary prevention of coronary heart disease in the elderly (with emphasis on patients ≥ 75 years of age), the ACCF and the AHA recommend that coronary risk factors in elderly patients should be managed similarly to those in younger patients.²²³

As Table 29 shows, elderly patients with cardiovascular disease have many complications and poor physical functions that often limit participation in cardiac rehabilitation programs. However, a number of studies have reported that the beneficial effect of cardiac rehabilitation programs on elderly patients are similar to those on younger patients.^{224,225} The results of

these studies in elderly patients were fairly consistent with the results of RCTs and meta-analyses of studies of cardiac rehabilitations in younger patients (Tables 30 and 31).^{226–230}

1. Significance of Exercise Training in Elderly Patients (Table 32)

It has been reported that exercise training improves physical functions and QOL in elderly patients with cardiovascular diseases.^{231–233} Reports have also described that exercise train-

Table 29. Characteristics of Elderly Patients With Cardiovascular Disease

1. Women are more common as compared with the sex ratio in younger patients.
2. The number of cardiac surgery and the incidence of heart failure is high.
3. Patients with underlying diseases (e.g., carotid atherosclerosis, arteriosclerosis obliterans, chronic respiratory failure, chronic kidney disease, stroke, cognitive disorder, and orthopedic disorders) are common.
4. Many patients cannot continue cardiac rehabilitation programs due to the conditions such as atrial fibrillation, cognitive disorder, anemia, acute exacerbation of chronic kidney disease, massive pleural effusion requiring drainage, respiratory support, and infections.
5. The rate of discharge to home is low: social resources should be applied.

Table 30. Characteristics of Elderly Patients With Acute Myocardial Infarction (AMI)

1. The rate of participation in cardiac rehabilitation decreases as the age increase. The rate is low among elderly patients and women of all ages.
2. The mortality and incidence of recurrent myocardial infarction are low among patients participating in cardiac rehabilitation after AMI. Survival rate among this patient population is not higher than the reference population.

Table 31. Effects of Cardiac Rehabilitation Programs Among Patients Over 65 Years Old With Coronary Artery Disease

1. Better management of coronary risk factors
2. Prevention of cardiovascular events
3. Decrease in mortality rate

Table 32. Effects of Aerobic Exercise and Resistance Training

1. Improvement in muscle strength
2. Decrease in the incidence of orthostatic hypotension
3. Improvement in vision
4. Improvement in exercise capacity (peak $\dot{V}O_2$, AT $\dot{V}O_2$, 6-minute walking distance: MD, walking and stair climbing)
5. Improvement in coronary risk factors (e.g., lipid metabolism, blood pressure, and body composition)
6. Improvement in autonomic nervous system function (QTc interval, heart rate variability, and BRS)
7. Improvement in vascular endothelial function
8. Improvement in mental/psychological factors such as health-related QOL and depression
9. Decrease in proinflammatory cytokine levels in patients with heart failure
10. Improvement in cardiac function

AT $\dot{V}O_2$, oxygen uptake at anaerobic threshold; BRS, baroreflex sensitivity; peak $\dot{V}O_2$, peak oxygen uptake; MD, minutes distance.

Table 33. Exercise Prescriptions for Elderly Patients With Heart Failure**Aerobic exercise**

Intensity	- 60% of peak $\dot{V}O_2$
- 50% of maximum exercise intensity
- 70% of maximum heart rate
- AT
- Borg scale of 11~13 (RPE: fairly light-somewhat hard)
Duration	20~60 min/session
Frequency	2~5 sessions/week

Resistance training

Intensity	40~60% of 1RM
Number of repetitions	One set consists of 12~15 repetitions
One session consists of 2~3 sets
Frequency	3 sessions/week

Interval training

Intensity	1. Vigorous: 90~95% of maximum heart rate
Light: 50~70% of maximum heart rate
2. Increase exercise intensity to Borg scale of 18 (RPE: very, very hard) in 5~10 minutes, then decrease gradually to 10 watts.
Duration	1. Interval training consists of 4-minute vigorous exercise followed by 3-minute light exercise for a total of 20~25 minutes.
2. Conduct 3 sets of interval training for a total of 40~50 minutes.
Frequency	3 sessions/week

1RM, one repetition maximum; AT, anaerobic threshold; peak $\dot{V}O_2$, peak oxygen uptake; RPE, ratings of perceived exertion.

ing significantly prolonged the duration of continuous exercise in elderly patients with heart failure,^{75,234,235} and that exercise training that started in the early phase after hospitalization shortened the duration of hospital stay, decreased the frequency of rehospitalizations, and reduced healthcare cost in elderly patients with MI. It also has been reported that home-based exercise training programs are beneficial in maintaining exercise capacity and reducing healthcare costs in low-risk patients after MI.^{236,237} There has been increasing evidence from large-

scale epidemiological studies and RCTs on the safety of exercise training and the role of comprehensive programs for elderly patients with cardiovascular diseases.^{228,238-241} Elderly patients should be strongly encouraged to participate in cardiac rehabilitation programs.

Class I

1. Aerobic exercise programs is recommended for elderly patients with CAD and those with heart failure. (**Level of**

Evidence: A)

- Exercise intensity in aerobic exercise is recommended to be moderate (around the AT) in elderly patients with CAD. (**Level of Evidence: A**)

Class IIa

- It is appropriate that exercise prescriptions for elderly patients with CAD include outpatient supervised and home-based non-supervised exercise training. (**Level of Evidence: B**)

Class IIa'

- It is appropriate that exercise training programs for elderly patients with CAD or heart failure consist of aerobic training and resistance training. It is appropriate that nutritional therapy and resistance training be prescribed for patients with reduced muscle mass. (**Level of Evidence: C**)
- It is appropriate that the intensity of resistance training for elderly patients with CAD would be moderate, i.e., 40~60% of one repetition maximum (1RM). (**Level of Evidence: B**)

2. Exercise Training in Elderly Patients With Cardiovascular Diseases

1. Exercise Prescriptions (Table 33)

2. Places

After patients experienced supervised exercise training in medical institutions, home-based training programs should be added and increased as the main component of continuing exercise.

There might be a concern that elderly patients with heart failure are at a high risk for developing cardiovascular events during exercise. Although few report regarding cardiovascular events during exercise has been published in elderly patients with heart failure, elderly as well as younger patients should begin with supervised exercise training in medical institutions first to confirm the patients' response to exercise.

VII Exercise Training for Large Vessel and Peripheral Arterial Diseases

1. Rehabilitation in Patients With Large Vessel Diseases

Class I

None.

Class IIa'

- It is appropriate that patients planning to undergo large vessel surgery perform exercise training to enhance respiratory function; this should be performed during blood pressure monitoring. (**Level of Evidence: C**)
- Cardiac rehabilitation after large vessel surgery is an appropriate intervention as it may decrease the duration of

Table 34. Effects of Rehabilitation Programs for Patients After Large Vessel Surgery

- Rehabilitation is expected to decrease hospital days by improving cardiopulmonary function and strengthening muscles.²⁴⁵
- Rehabilitation decreases the incidence of postoperative complications (e.g., infections, pneumonia, pleural effusion, and delirium).
- Rehabilitation improves prognosis and QOL.²⁴⁶

Table 35. Rehabilitation by Type of Aneurysm

Type of aneurysm	Management
True aneurysm	Basic postoperative rehabilitation programs
Aortic dissection after surgery	
No residual dissection or false lumen	Basic postoperative rehabilitation programs
Presence of residual dissection or false lumen	Individualized management and more strict blood pressure control are required.
Pseudo aneurysm	Appropriate management varies by the cause of pseudo aneurysm (e.g., injuries and Behcet's disease). After radical surgery, patients may participate in rehabilitation programs similarly as do patients with true aneurysm.

Table 36. Rehabilitation by Location of Aneurysm

Location	Affected organ systems/ pain location	Conditions requiring management to improve ADL after surgery
Thoracic aortic aneurysm		
Ascending aorta/arch	Respiratory system	Conditions such as swallowing disorders and residual dissection Control of pleural effusion
Descending aorta		
Abdominal aortic aneurysm	Bowel system	Gastrointestinal symptoms such as anorexia (dietary habit before surgery is useful information)

ADL, activities of daily living.

Table 37. Points for Rehabilitation by Cause of Aneurysm

Cause	Characteristics
Atherosclerosis	<ul style="list-style-type: none"> - Most common cause of aneurysm. - Common in elderly patients. - Prevention of disuse syndrome is important. - Because systemic complications are commonly observed, patients should be observed for cerebral ischemia, ischemic heart disease, renal ischemia, and arteriosclerosis obliterans (leg ischemia).
Marfan's syndrome	<ul style="list-style-type: none"> - Relatively common in younger patients. - Concomitant non-cardiac atherosclerotic disease is rare, but tissues are fragile. - It has been reported that angiotensin II receptor blockers significantly slowed the rate of progressive aortic-root dilation.²⁴⁷

Table 38. An Example of Stepwise Rehabilitation After Endovascular Stent Grafting

Table 60-10 Example of Stepwise Rehabilitation After Endovascular Stent Grafting			
Date		Exercise	Level of activity
Day of stenting			Bed rest
Day 1 after stenting	100 m walking test	Target rate: 2 mph (about 54 m/min) (about 2.0~2.5 METs) *If difficult, start walking at the patient's own pace. Require nurse aide during first test.	When walking test is passed, the patient is allowed to walk in the ward freely. However, long-distance walking is not recommended. Walking should be limited to going to the toilet.
Day 2 after stenting	300~500 m walking test		When walking test is passed, the patient is allowed to walk in the hospital freely.

METs, metabolic equivalents.

Table 39. Characteristics of Patients With Aortic Disease by Location

Thoracic aortic aneurysm (TAA)
- More common in ≤ 60 years old.
- Saccular aneurysm accounts for about 30% of cases.
- The most common location is the arch for saccular aneurysm and the descending aorta for fusiform aneurysm.
- Male: female ratio is about 3~4:1.
Thoracoabdominal aortic aneurysm
- More common among patients in their 50~60s (Younger than patients with TAA).
- Male: female ratio is about 4:1.
Abdominal aortic aneurysm (AAA)
- Most common among patients in their 60~70s.
- Results of surgery in elderly patients are as good as younger patients.
*However, the prognosis is poor in patients ≥ 80 years old, male patients, patients with chronic renal failure, patients with peripheral arterial disease, and patients undergoing emergency surgery.
- Male: female ratio is 5~8:1.
- Prognosis is poor in women.
- The prevalence and mortality of ruptured aneurysm is higher in women than that seen in men.
Inflammatory
- Inflammatory AAA accounts for about 4% of all AAA.
- Male: female ratio is 6:1.
Aortic dissection (including dissecting aortic aneurysm)
- Common among patients in their 50~60s.
- Male: female ratio is about 3:1.
- About half of female patients are ≥ 70 years old. Mortality due to aortic dissection is higher in women than that seen in men.

hospital days, result in early return to society and a high rate of successful returning to work, improve prognosis and QOL, and enhance postoperative recovery in elderly patients by enhancing cardiopulmonary functions and strengthening muscles. (Level of Evidence: C)

1. Current Practice of Rehabilitation Programs for Patients After Large Vessel Surgery

Early introducing of rehabilitation programs for patients after large vessel surgery is increasingly common, and has facilitated early discharge from hospitals.²⁴²

Patients with acute aortic dissection are undergoing rehabilitation according to the recommendations on cardiac rehabilitation programs.^{243,244}

Table 40. Items to Be Monitored and Assessed During Rehabilitation After Large Vessel Surgery

1. Blood pressure control (maintain optimal blood pressure)
 - Maintain systolic blood pressure at ≤ 130 mmHg.
2. Exercise stress test
 - Expand activity serially to sitting, standing, walking around the ward, taking a shower, taking a bath, and physical exercise.
 - In addition to walking, exercise tests may include treadmill and cycle ergometer exercises.
 - Target systolic blood pressure is ≤ 130 mmHg before exercise and < 150 mmHg during exercise.
3. 24-hour blood pressure monitoring
4. QOL survey
 - QOL survey is recommended as it helps with prescribing and revising/refining exercise training programs.

Table 41. Criteria for Terminating Rehabilitation Program After Large Vessel Surgery

1. Inflammation
 - Fever $\geq 37.5^{\circ}\text{C}$
 - Inflammatory findings (rapid increase in CRP levels)
2. Arrhythmia
 - Occurrence of severe arrhythmia
 - Consult physicians when tachycardiac atrial fibrillation develops
3. Anemia
 - A rapid decrease in hemoglobin concentration to ≤ 8.0 g/dL
 - Consult physicians when hemoglobin concentration decreases to around 7.0 g/dL in patients undergoing no-transfusion surgery
4. Oxygenation
 - Decrease in SpO_2 ($\leq 92\%$ during oxygen therapy or exercise-induced decrease by $\geq 4\%$)
5. Blood pressure
 - Resting SBP at the start of ambulation: ≤ 100 mmHg or ≥ 140 mmHg
 - SBP during ambulation: a decrease by ≥ 30 mmHg from the level at the start of ambulation
 - SBP before exercise training: ≤ 100 mmHg or ≥ 160 mmHg
6. Ischemic ECG changes or a heart rate of ≥ 120 bpm

CRP, C reactive protein; SBP, systolic blood pressure; SpO_2 , peripheral arterial oxygen saturation.

Source: Guidelines for Rehabilitation in Patients with Cardiovascular Disease (JCS2007),²⁵¹ and Watanabe S, et al. The inhibiting factors of physical therapy in aortic dissection repair. *Physical Therapy Japan* 2005; **32**: 72–76.²⁵²

2. Effects of Rehabilitation Programs for Patients After Large Vessel Surgery (Table 34)^{245,246}

3. Conditions to Be Considered When Prescribing Rehabilitation Programs for Patients After Large Vessel Surgery

(1) Rehabilitation Programs by Type of Aortic Aneurysm (Table 35)

(2) Rehabilitation Programs by Location of Aortic Aneurysm (Table 36)

(3) Rehabilitation Programs by Cause of Aortic Aneurysm (Table 37)²⁴⁷

(4) Rehabilitation Programs by Treatment Method of Aortic Aneurysm

Endovascular stent grafting is a minimally invasive technique for the treatment of aortic aneurysm and dissection (Table 38). After stenting, patients may be able to start walking early after surgery, be discharged from the hospital 7 days after stenting, and live as usual when return home.

Target systolic blood pressure and heart rate in patients after large vessel surgery are ≤ 130 mmHg and ≤ 70 bpm at rest,

and ≤ 140 mmHg and ≤ 90 bpm during exercise, respectively.²⁴⁸

In patients with thoracic aortic aneurysm complicated with spinal cord injury with paraplegia, blood pressure should be maintained at a higher level because a decrease in blood pressure may exacerbate symptoms.

(5) Rehabilitation in Patients Undergoing Elective Surgery for Non-Ruptured Aortic Aneurysm and Patients Undergoing Emergency Surgery for Ruptured Aortic Aneurysm

The condition and risk management of patients differs between those undergoing elective surgery for non-ruptured aortic aneurysm and those undergoing emergency surgery for ruptured aortic aneurysm. Patients with ruptured aneurysm have poor general condition, often experience postoperative complications, and undergo surgery with no preoperative assessment. After surgery, they participate in cardiac rehabilitation without detailed information on underlying diseases such as CAD, cerebrovascular disorder, and pulmonary disease.

4. Patient Characteristics by Age and Gender (Table 39)

Patients after thoracic aortic graft replacement and elderly patients after large vessel surgery may experience swallowing disorders, and should be considered for swallowing assess-

Table 42. An Example of a Rehabilitation Program for Patients After Large Vessel Surgery

	Patients without residual dissection	Patients with residual dissection	Patients with descending thoracic aortic aneurysm
Blood pressure	SBP $\leq$ 160mmHg	SBP $\leq$ 140mmHg	SBP $\leq$ 140mmHg
Stage			
I	Start on postoperative day 1	Complete on postoperative day 7	Complete on postoperative day 3
II	Start on postoperative day 2	Complete on postoperative day 14	Start on postoperative day 3
III	Start on postoperative day 3	Start on postoperative day 14 with careful observation for thrombosis of residual false lumen	Start on postoperative day 5 with careful monitoring of oxygenation
IV	Start on postoperative day 4		
V	Start on postoperative day 5		
VI	Start on postoperative day 6	Start on postoperative day 21	Start on postoperative day 10
VII	Start on postoperative day 7		

SBP, systolic blood pressure.

Adapted from Watanabe S. Cardiac surgery and physical therapy for elderly or disabled patients. *The Japanese Journal of Physical Therapy* 2005; **39**: 771–776.²⁵⁴

Table 43. An Example of a Rehabilitation Program for Patients After Abdominal Aortic Aneurysm Surgery (Cardiovascular Center, Saiseikai Kumamoto Hospital)

Stage	Day	Level of activity	Meals	Area of movement & Toilet	Bed bath
1	Day of surgery	30-degree head-of-bed elevation	No meals/water	On the bed	Dry bath
2	Postoperative day 1	Sitting on the edge of the bed	Water	Bedside commode	Dry bath
3	Postoperative day 2	Walking exercise	Rice porridge	Ward toilet	Dry bath
4	Postoperative day 3~4	Walking exercise	Regular meals	Ward toilet	Lower body shower
5	Postoperative day 5~10	Exercise training (e.g., ergometer exercise)	Regular meals	Hospital	Bath
				Discharge	

Adapted from Nishigami K. Rehabilitations for complications of aortic disease. *J Jpn Soc Int Med* 2010; **99**: 87–91.²⁵⁵

Table 44. An Example of Stepwise Rehabilitation After Large Vessel Surgery

Exercise	Methods	Level of activity
2-minute stepping	Stand up slowly at the bedside for oneself, and step in place for 2 minutes	
50m walking	Target rate: 2 mph (about 54 m/min) (about 2.0~2.5 METs) *If difficult, start walking at the patient's own pace.	When test is passed, allow to use ward toilet.
100m walking		
300m walking		
500m walking		
Exercise training room	Exercise training such as walking, treadmill walking, and cycle ergometer (low level of exercise intensity is recommended).	When test is passed, allow to take a shower.

METs, metabolic equivalents.

ment and training by dentists, speech therapist, or other appropriate health professionals. It is preferable to provide appropriate preoperative approaches and serve goeey food diet after surgery whenever possible to promote the recovery of swallowing function.²⁴⁹

5. Rehabilitation for Patients After Large Vessel Surgery

(1) Monitoring and Assessment During Rehabilitation After Large Vessel Surgery (Table 40)

(2) Criteria for Terminating Rehabilitation Programs (Table 41)^{250–252}

(3) Stepwise Implementation of Rehabilitation

1. Patients should receive preoperative training to enhance

respiratory function. Patients with abdominal aortic aneurysm (3~5 cm in diameter) may undergo CPX safely.²⁵³

- After surgery, patients should be encouraged to expand the range of ADL step by step (Table 42).²⁵⁴
- Characteristics of each stage and stepwise process of rehabilitation (Tables 43²⁵⁵ and 44)

6. Treatment and Effects of Rehabilitation on Systemic Atherosclerotic and Venous Diseases

Inflammation is an important pathophysiological feature of aortic aneurysms. In a double-blind, placebo-controlled trial in patients undergoing vascular surgery (50% of them underwent abdominal aortic aneurysm repair), statins decreased the incidence of postoperative cardiovascular events.²⁵⁶

It has been reported that deep vein thrombosis and pulmo-

Table 45. Arterial Occlusive Diseases That May Cause Claudication**Causes of occlusive arterial lesions in lower extremity arteries potentially causing claudication**

- Atherosclerosis (arteriosclerosis obliterans [ASO])
- Arteritis
- Congenital and acquired coarctation of aorta
- Endo-brosis of the external iliac artery (iliac artery syndrome in cyclists)
- Fibromuscular dysplasia
- Peripheral emboli
- Popliteal aneurysm (with secondary thromboembolism)
- Adventitial cyst of popliteal artery
- Popliteal arterial entrapment
- Primary vascular tumors
- Pseudoxanthoma elasticum
- Remote trauma or irradiation injury
- Takayasu's disease
- Thromboangiitis obliterans (Buerger's disease)
- Thrombosis of a persistent sciatic artery

Adapted from Norgren L, et al. Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). *J Vasc Surg* 2007; **45**(Suppl S): S5–S67,²⁵⁸ with permission from Elsevier Inc.

nary embolism developed in 8.1% of patients after abdominal aortic aneurysm repair.²⁵⁷

2. Peripheral Arterial Rehabilitation in Patients With Chronic Peripheral Arterial Occlusive Diseases

Class I

1. Exercise training programs for patients with intermittent claudication is recommended to prescribe according to the presence and severity of ischemia using the ankle brachial pressure index (ABPI). **(Level of Evidence: B)**
It is also recommended that patients undergo vascular ul-

trasound, magnetic resonance (MR), magnetic resonance angiography (MRA) or computed tomography (CT) to investigate the etiology and pathology (location of lesions and severity of stenosis) of intermittent claudication. **(Level of Evidence: B)**

2. Exercise training, especially supervised exercise training, is recommended for patients with intermittent claudication due to chronic peripheral arterial occlusive disease whenever it is not contraindicated. **(Level of Evidence: A)**
It is desirable that exercise intensity be prescribed. Exercise machines such as treadmills and ergometers should be used. Use of a walking track equipped with a pacemaker is also acceptable. **(Level of Evidence: A)**
Exercise programs are recommended to continue for 3

Table 46. Classification of Peripheral Circulatory Disturbance: Fontaine's Stages and Rutherford's Categories				
Fontaine		Rutherford		
Stage	Clinical symptoms	Grade	Category	Clinical symptoms
I	Asymptomatic	0	0	Asymptomatic
IIa	Mild claudication	I	1	Mild claudication
IIb	Moderate to severe claudication	I	2	Moderate claudication
		I	3	Severe claudication
III	Ischemic rest pain	II	4	Ischemic rest pain
IV	Ulceration or gangrene	III	5	Minor tissue loss
		III	6	Major tissue loss

Adapted from Norgren L, et al. Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). *J Vasc Surg* 2007; **45**(Suppl S): S5–S67,²⁵⁸ with permission from Elsevier Inc.

Figure 9. Algorithm for diagnosis of peripheral arterial disease (PAD). ABPI, ankle-brachial pressure index; PVR, pulse volume recording; TASC, TransAtlantic Inter-Society Consensus; TBPI, toe brachial pressure index; VWF, velocity wave form. Adapted from Norgren L, et al. Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). *J Vasc Surg* 2007; **45**(Suppl S): S5–S67,²⁵⁸ with permission from Elsevier Inc. *Modified in accordance with 2011 ACCF/AHA Focused Update of the Guidelines.²⁶⁵

months or longer. **(Level of Evidence: A)**

3. Patients with arteriosclerosis obliterans (ASO) should be carefully examined for systemic complications and prognosis. Exercise programs should be prescribed after careful assessment for complications of major organs (especially ischemic heart disease). **(Level of Evidence: B)**
The use of antiplatelet drugs is recommended as a measure to decrease the risk of cardiovascular complications and death in patients with ASO. **(Level of Evidence: A)**

Class Ila

1. Combination of drug treatment and home-based exercise training programs is an appropriate regimen for patients

with intermittent claudication who cannot participate in supervised exercise training. **(Level of Evidence: C)**

Introduction

The type of intermittent claudication for which exercise training is recommended in the present guidelines is ischemic claudication due to chronic obstruction of peripheral arteries. When detailed pathological classification of intermittent claudication is required, descriptions such as “arteriosclerosis obliterans (ASO)” and other types of chronic arterial stenosis/occlusion such as “Buerger’s disease (thromboangiitis obliterans), a chronic inflammatory disease”, are made. **Table 45** lists arterial occlusive diseases that may cause claudication.²⁵⁸

- The patient must receive a full explanation on how to walk on the treadmill, and must perform a trial walk as well as take a rest before the examination.
- ECG should be monitored throughout the examination.
- ABPI should be measured before treadmill walking.
- The grade of the treadmill should be 12 degrees, and the walking speed should be 2.4 km/h.
- The patient should keep a good posture during walking, and should not lean on the handle.
- Pain-free walking distance and maximum walking distance should be determined (Record the sites of pain).
- ABPI should be remeasured immediately after the end of treadmill walking test.

Figure 10. Determination of treadmill walking distance. ABPI, ankle-brachial pressure index (also referred to as ABI and API). Normal range is 0.90~1.40. An ABPI of <0.90 is considered abnormal.

Table 47. Treatment Guidelines According to Fontaine's Stages		
Fontaine's stage	Clinical findings	Treatment policy
I	Asymptomatic (cold foot, numbness)	Eliminate risk factors and prevent the progression of peripheral arterial disease
II	Intermittent claudication	Treatment for type I patients plus exercise training, drug treatment, and invasive treatment
III	Pain at rest	Conduct invasive treatment first to salvage limbs
IV	Gangrene or ischemic ulcer	

1. Effects of Exercise Training

(1) Increase in Walking Distance

Exercise training increases walking distance in patients with ischemic claudication.²⁵⁹ In a multicenter study in 53 patients in Japan, exercise training increased walking distance (See Table 51 of the full version of the guidelines).²⁶⁰

(2) Effects on QOL and Prognosis

- Effects on QOL (MOS 20-item Short Form Health Survey [SF-20],²⁶¹ SF-36,²⁶² Walking Impairment Questionnaire [WIQ]²⁵²)
- Effects on long-term prognosis²⁴⁷

(3) Cost-Effectiveness

2. Mechanism of Effects of Exercise Training (Figure 8)²⁶³

3. Precautions for Implementation of Exercise Training for Ischemic Claudication

(1) Definitive Diagnosis of Peripheral Arterial Occlusive Disease (Table 46²⁵⁸, Figures 9^{258,264,265} and 10)

(2) Complication of Systemic Atherosclerotic Diseases

Patients with ASO due to atherosclerosis may have systemic, for example, cerebral, carotid, coronary, or renal arteries resulting in systemic complications. Patients with ASO should be carefully assessed for systemic condition including complications in major organs (especially coronary heart disease),

and prognosis before prescribing exercise training programs for claudication.

(3) Sex Difference

The male-female ratio of patients with intermittent claudication is 9:1. But the incidences differ according to age. The incidence in female patients increases as age increases.

(4) Positioning of Exercise Training in the Treatment of Chronic Peripheral Arterial Occlusive Disease (Table 47)

Basic treatment strategies for ASO include (1) treatment of peripheral circulatory disturbance, (2) treatment of circulatory disturbance in other organs, and (3) management of risk factors for atherosclerosis.

4. Exercise Training for Patients With Chronic Peripheral Arterial Occlusive Diseases

(1) Indications and Contraindications of Exercise Training (Figure 11)²⁶⁶

It has been proposed that ABPI recovery time after one-minute walk on a treadmill at grade 12% and a speed of 2.4 km/h should be determined before prescribing exercise training programs, and patients with an ABPI recovery time of ≤12 minutes are expected to improve walking distance after exercise training.²⁶⁷

A combination with supervised exercise training after bypass surgery is also recommended.

Table 48. Exercise Prescriptions for Patients With Chronic Peripheral Arterial Occlusive Disease	
Method	Supervised exercises are recommended
Type	<ul style="list-style-type: none">- Treadmill walking.- Exercise training programs should consist of (1) warm-up, (2) walking exercise, and (3) cool-down.- Patients whose major lesions are located in the lower legs, especially those with thromboangiitis obliterans may try Börger's exercise and Ratschow's exercise of which the load to muscles affected by peripheral ischemia can be modified.- A recent study has reported that dynamic arm exercise training can improve walking capability in patient with claudication. This may become a component of exercise programs.
Intensity	<ul style="list-style-type: none">- Walking exercise should start at grade of 12% and a speed of 2.4 km/h. The patient should walk at a New Borg scale of 6~8/10 until he/she experiences leg pain (note that the New Borg scale [scale from 1 to 10] is used for the treatment of chronic peripheral arterial occlusive disease rather than the conventional Borg scale. See Table 49).- When the patient can walk at the above intensity for 10 minutes, the exercise should be intensified to a speed of 3.2 km/h or a higher grade. When the patient can walk at the higher speed, the speed may be further increased to 4.8 km/h.
Time, interval, and duration	<ul style="list-style-type: none">- One session of walking exercise should last between 30 to 60 minutes.- The patient should perform 1~2 sessions per day, at least 3 days per week (whenever possible ≥5 days per week).- The patient should walk until he/she feels leg pain similar to the previous pain, and then rest until the pain subsides repeatedly (for about 1~5 minutes).- Walking exercise is usually continued for 3~6 months.- It has been reported that walking exercise should be continued for at least 2 or 3 months.
Monitoring	<ul style="list-style-type: none">- The patient must be monitored for heart/pulse rate and blood pressure. ECG monitoring should also be performed.

Table 49. The Borg Scale and the New Borg Scale for Ratings of Perceived Exertion (RPE)

Borg scale		New Borg scale	
Scale	RPE	Scale	RPE
20	Maximum exertion	0	Nothing at all
19	Very, very hard	0.5	Very, very weak
18		1	Very weak
17	Very hard	2	Weak
16		3	Moderate
15	Hard	4	Somewhat strong
14		5	Strong
13	Somewhat hard	6	
12		7	Very strong
11	Fairly light	8	
10		9	Very, very strong
9	Very light	10	Maximum exertion
8			
7	Very, very light		
6			

Adapted from Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc* 1982; **14**: 377–381,²⁶⁸ with permission from Wolters Kluwer Health.

Table 50. How to Motivate Patients to Exercise

1. Interview the patient in detail to obtain information necessary to provide practical advice to modify lifestyle.
2. The instructor should walk with the patient whenever possible to make exercise more engaging.
3. Discuss specific feasible exercise prescriptions with the patient, and try prescriptions (talk with the patient with a positive attitude such as “Let’s try. If you fail, try again”).
4. Instruct the patient to keep an exercise log and record pedometer counts (as same as measurements of blood pressure and blood glucose). Encourage family members to support the patient.
 - 1) Set specific numerical goals (self-validation)
 - 2) Instruct the patient to remind the goals every day (repetition)
 - 3) Encourage family members to remind the patient of the goals (repetition)

Source: Yasu T, et al. Exercise training for vascular diseases. *Journal of the Japanese Association of Cardiac Rehabilitation (JJCR)* 2008; **1**: 39–42.²⁶⁹

(2) Exercise Prescriptions (Tables 48 and 49²⁶⁸)

(3) How to Motivate Patients Participating in Exercise Programs (Table 50)²⁶⁹

It has been reported that about 50% of patients who have been able to continue exercise training for 2 weeks can continue exercise training thereafter.

Patients undergoing exercise training should be supported and followed up by healthcare professionals and staff members of cardiac rehabilitation programs.²⁶⁹ Multidisciplinary patient education is also important to develop a patient’s better understanding of prescribed exercise training.

(4) Home-Based Exercise Training

Patients should walk fast with a pedometer at a New Borg scale of 6–8/10 (“somewhat strong”). Patients should be instructed to perform 30-minute walking exercise sessions twice a day, 5 days a week. One session should consist of sequences of walking a little faster than usual until pain develops and a several-minute rest until pain disappears.

5. Exercise Training and Life Style Management to Control Risk Factors for Atherosclerosis

- (1) Exercise training
- (2) Risk factor management: Goals include smoking cessation, LDL cholesterol <100 mg/mL, hemoglobin A1c (HbA1c) (NGSP [National Glycohemoglobin Standardization Program]) <7.0%, and blood pressure <140/90 mmHg.
- (3) Use of antiplatelet drugs to prevent cerebrovascular and cardiovascular diseases.^{258,270}
- (4) Use of β -blockers in patients after AMI to improve prognosis.²⁷¹

6. Combination of Exercise Training and Drug Treatment in Patients With Intermittent Claudication

Exercise training is the first choice treatment for ischemic claudication.^{272,273} Drug treatment is also effective.^{274–276} (**Level of Evidence: C**)

The combination of drug treatment and exercise training is also recommended for patients with ischemic claudication.^{277–280}

A combination of heparin therapy (administer 3,000 IU 60 minutes before exercise training) and exercise training for 14 days is also effective.²⁸¹

VIII Psychological Approaches for the Rehabilitation in Patients With Cardiovascular Diseases

Class I

None.

Class IIa'

- 1. Because the prevalence of depression and depressed state is high among patients with CAD, and depression has been reported to relate to increased morbidity and mortality from cardiovascular diseases, screening for and treatment of depression by specialists are useful for this patient population. (Level of Evidence: B)

Class IIb

- 1. Screening of depressed mood or other psychological symptoms as well as psychological intervention for the prevention and treatment of depression are expected to alleviate psychological symptoms, improve QOL, enhance adherence to treatment, and reduce the mortality and incidence of cardiovascular events. (Level of Evidence: C)
- 2. Therapeutic interventions for patients with certain psychosocial characteristics such as Type D (distressed) personality are expected to reduce the mortality and incidence of cardiovascular events. (Level of Evidence: C)

1. Importance of Clinical Psychological Interventions for Patients With Cardiovascular Diseases

Patients with cardiovascular diseases often experience psychological symptoms such as depression and anxiety disorders that are known to significantly affect life expectancy and prognosis by increasing mortality and the incidence of cardiovas-

cular events in this patient population.²⁸²⁻²⁸⁹ It also has been reported that psychological stress associated with physical stress, anxiety and depression, and Type D personality may predict the health status of patients with cardiac disease.^{284,290-292}

The prevalence of depression among patients with AMI is about 3 times higher than that seen in the general population, and 15~20% of patients with AMI have a major depressive disorder (MDD)^{293,294} as defined in the DSM-IV-TR (*Diagnostic and Statistical Manual of Mental Disorders*, 4th edition, text revision) (Table 51).^{295,296} Similar prevalence of MDD have been reported among patients with unstable angina, those after PCI, CABG and valve surgery, and a higher prevalence of MDD has been reported in patients with chronic heart failure.^{297,298} Depression not only substantially deteriorates QOL in patients with cardiac disease,^{299,300} but also decreases adherence to drug treatment,³⁰¹ leads poor lifestyle choices such as decreased physical activity and increased smoking that may increase the risk of cardiovascular disease. And reduce compliance with treatment and lifestyle intervention plans that are essential to modify cardiovascular risk factors,³⁰² attendance at cardiac rehabilitation programs,^{303,304} and increases health-care costs.^{282,305} It has recently been advocated that screening and intervention for depression are essential for patients with cardiovascular diseases.

Reports have described that psychological factors such as anger, Type D personality, and psychological stress associated with physical stress, anxiety, and depression, may predict health status in patients with cardiovascular diseases.^{284,290-292} Additionally, Type D personality is reported to be more strongly related to cardiac mortality and incidence of cardiac events than other factors such as decreased LVEF, impaired exercise capacity, and the presence/absence of three-vessel disease.

Table 51. Criteria for Major Depressive Episode
A. At least five of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure. 1. Depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad or empty) or observation made by others (e.g., appears tearful). 2. Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation made by others). 3. Significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a month), or decrease or increase in appetite nearly every day. 4. Insomnia or hypersomnia nearly every day. 5. Psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down). 6. Fatigue or loss of energy nearly every day. 7. Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick). 8. Diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others). 9. Recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide.
B. The symptoms do not meet criteria for a mixed episode.
C. The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.
D. The symptoms are not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition (e.g., hypothyroidism).
E. The symptoms are not better accounted for by bereavement, i.e., after the loss of a loved one, the symptoms persist for longer than 2 months or are characterized by marked functional impairment, morbid preoccupation with worthlessness, suicidal ideation, psychotic symptoms, or psychomotor retardation.

Source: American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, 4th edn, Text Revision (DSM-IV-TR). Washington, DC: American Psychiatric Association, 2000.²⁹⁵

Table 52. Psychological, Mental and QOL Scales Commonly Used for Patients With Cardiovascular Diseases

Evaluation	Title of questionnaire	Number of questions/contents
Anxiety	STAI: State-Trait Anxiety Inventory	40 questions. A measure of state anxiety and trait anxiety.
Depression	PHQ-9: Patient Health Questionnaire-9	10 questions. A measure used as a screening tool for depression (measure of depressive state). *An application for research use may be required.
Depression	BDI-II: Beck Depression Inventory-Second Edition	21 questions. Measure depressions over the previous 2 weeks (weight on mood and cognition).
Depression	SDS: Self-rating Depression Scale	20 questions. Self-rating depression scale (severity of depression and efficacy evaluation).
Depression	CES-D: Center for Epidemiologic Studies Depression Scale	20 questions. Self-rating scale for depression (depressive state).
Depression	HDRS: Hamilton Rating Scale for Depression (HAM-D)	17 questions (21 or 24 questions in some language versions). An interview scale used by specialists.
Depression/anxiety	HADS: Hospital Anxiety and Depression Scale	14 questions. A scale for evaluation of depression and anxiety in patients with physical diseases.
Emotion/mood	POMS: Profile of Mood States	65 questions. A scale to assess transient, fluctuating active mood states.
Type D personality	DS14: Type D Scale-14	14 questions. A Type D (distressed) personality scale based on negative affectivity and social inhibition.
Anger	STAXI-2: State-Trait Anger expression Inventory-2 (Upgrade version of STAXI)	57 questions. Developed to assess state anger, trait anger, and anger expression.
Personality inventory	MMPI: Minnesota Multiphasic Personality Inventory	550 questions. An international questionnaire that evaluates personality traits multilaterally and is translated into 130 languages.
Mental health	GHQ: General Health Questionnaire	60 questions (*Shorter versions consist of 30/28/12 questions). A scale to diagnose and evaluate the severity of mental disorders (mental health).
QOL	SF-36: The 36-item short form of the Medical Outcomes Study Questionnaire	36 questions. A scale of health-related QOL including physical function and role-emotional limitation.
QOL	WHO/QOL-26: WHO/Quality of Life-26	26 questions. A measure of QOL consisting of physical domain, psychological domain, social relationships, environment, and 2 items for general QOL.

This possible correlation is receiving increasing attention.³⁰⁶

2. Psychological Assessment of Patients With Cardiovascular Diseases

Psychological assessment should include (1) careful consideration of the patient's physical/mental-health status to select suitable methods for assessment, (2) appropriate feedback of the results of assessment, and (3) satisfactorily explained to all staffs with thoughtful word to share necessary information. The third point is most important in patients who have prejudice or resistance against mental health issues may deny their symptoms or have a feeling of anger or resistance when psychological assessment is suggested. Physicians and staff members should fully explain about the importance of psychological assessment and provide adequate support to patients.³⁰² Table 52 lists psychological, mental and QOL measures that are commonly used for rehabilitation in patients with cardiovascular diseases.

3. Psychological Interventions for Patients With Cardiovascular Diseases

The most common symptoms that require psychological interventions among patients with cardiovascular disease are depressive and anxious state. It has been reported that health outcomes are poorer among patients who have depression and a chronic physical disorder than for patients who have two or

more chronic physical disorders.³⁰⁷ The basic components of depression treatment are drug treatment and psychological therapy. Although the efficacy of antidepressants has been established most convincingly in the treatment of MDD, it has been pointed out that the efficacy depends on the severity of depression.³⁰⁸ And more antidepressants are not recommended as first-line therapy for patients with mild depression, because they do not respond to drug treatment as effectively as those in severe depression.³⁰⁹ Antidepressants are not indicated as first-line therapy for patients with mild depression, who have been reported to respond well to exercise and psychological therapy. Physicians should consider all available treatment options, and not limit their choices to antidepressants.³¹⁰

1. Drug Treatment

Depression and depressive states are commonly observed in patients with cardiovascular diseases.²⁹⁸ Antidepressants currently available in Japan include tricyclic antidepressants, tetracyclic antidepressants, selective serotonin reuptake inhibitors (SSRIs), serotonin and norepinephrine reuptake inhibitors (SNRIs), and noradrenergic and specific serotonergic antidepressants (NaSSAs). The AHA recommends sertraline* and citalopram** (both are SSRIs) as first-line therapy for patients with CAD and depression.³¹¹ These two SSRIs have been demonstrated in many clinical studies to be safe in patients with cardiovascular diseases and effective in the treatment of moderate or severe depression and recurrent depression. If the patient expresses suicidal ideation, has strong anxiety or irritation, or has no improvement after 2 months of treatment, the patient should be referred to a psychiatrist to provide multidis-

ciplinary treatment. Antidepressant treatment is usually continued as maintenance therapy for months or 1 year after symptoms of depression are controlled, and treatment should be tapered off gradually with careful monitoring for recurrence.

[Precaution Statement]

*Sertraline:

MEDSAFE (Medicines and Medical Devices Safety Authority) of New Zealand decided that Sertraline hydrochloride needs the similar precautions as citalopram hydrobromide.

on December 12, 2012. And Pfizer revised their CCDS (Company Core Data Sheet for Sertraline hydrochloride in Japan) on September 13, 2013.

**Citalopram:

In August 2013, The U.S. Food and Drug Administration (FDA) is clarifying dosing and warning recommendations for the antidepressant Celexa (citalopram hydrobromide) below. Citalopram is not recommended for use in patients with congenital long QT syndrome, bradycardia, hypokalemia, or hypomagnesemia, recent AMI, or uncompensated

heart failure.

2. Psychological Therapy

Psychological supports to patients with cardiovascular diseases are classified into (1) psychological patient education to assist patients to acquire skills in coping with mental stresses, (2) psychological therapy provided to alleviate depressed mood and anxiety or solve personal problems, (3) psychological interview to reduce psychological risks on diseases that provided as a component of comprehensive cardiac rehabilitation programs.

The efficacy of psychological therapy in patients with cardiovascular diseases has been investigated in studies using several methodologies such as interpersonal psychotherapy,³¹² cognitive behavioral therapy,^{310,313} and problem-solving therapy.^{314,315} Autogenic training, a relaxation technique to relieve insomnia and anxiety, is also used in this patient population.³¹⁶

3. Other Possibly Effective Approaches

Exercise training and aerobic exercise training conducted as a part of cardiac rehabilitation are effective in improving cardiovascular function, reducing mortality due to cardiovascular diseases, alleviating depressive state,^{317–319} and reducing psychosocial stress.^{320,321} Social supports help to alleviate psychological symptoms such as depression in patients with cardiovascular diseases,^{322–324} and should also cover family members who care for the patient.³⁰²

4. Psychological Interventions to Cardiac Rehabilitation

In addition to providing psychological interventions, psychologists may be involved in cardiac rehabilitation by (1) screening for mental disorders and providing appropriate feedback to cardiologists, (2) providing patient education (providing information) on the relationship between cardiovascular diseases and psychological symptoms such as depression, (3) alleviating psychological symptoms such as depressed mood and anxiety, (4) assisting patients to acquire skills in coping with mental stresses, (5) helping patients rebuild self-efficacy and self-confidence, maintain social relationships, prevent social isolation, and enhance social supports.³⁰⁴

Because continuous multidisciplinary supportive care is effective in alleviating symptoms of depression and suicidal ideation,³²⁷ psychologists should share their insights with other staff members involved in cardiac rehabilitation, and ensure the development of an efficient, appropriate multidisciplinary cardiac rehabilitation system.

Patients should be regularly screened for mental disorders and be monitored continuously because the presence/absence and severity of depressed mood and anxiety are affected by daily events and mental stress. In addition, since patients do not always exhibit more severe depressed mood or anxiety symptoms immediately after the onset of cardiovascular events (Figure 12).

IX Building an Exercise Training System

1. Approaches to Exercise Training Programs: How to Build Systems

1. A Prospective View of Cardiac Rehabilitation in Japan

(1) Efficient Use of Hospitals Providing Cardiac Rehabilitation Programs

Class I

1. It is recommended that patients participate in recovery-phase cardiac rehabilitation programs. (**Level of Evidence: A**)

Class IIa

1. Cardiac rehabilitation only during hospitalization. (**Level of Evidence: C**)

Patients should continue cardiac rehabilitation programs for life to prevent recurrent cardiac diseases and improve cardiac function. As the duration of hospitalization is becoming shorter, patients with cardiovascular diseases should participate in outpatient cardiac rehabilitation programs after discharge and utilize cardiac rehabilitation facilities that have the capacity to provide services to out-patients.

(2) Comprehensive Cardiac Rehabilitation Programs (Table 53)

Class I

1. It is recommended that cardiac rehabilitation programs include patient education sessions. (**Level of Evidence: A**)

It has been demonstrated that comprehensive cardiac rehabilitation programs that include patient education sessions re-

duce mortality by 73% as compared with programs consisting of exercise sessions only. It is desirable that cardiac rehabilitation programs should include not only exercise training, but also diet therapy, smoking cessation counseling, stress management, and lifestyle intervention.

2. Functions Required for Cardiac Rehabilitation

Class I

1. It is recommended that cardiac rehabilitation involve a multidisciplinary team including nurses, physical therapists and other exercise trainer. (**Level of Evidence: C**)

Cardiac rehabilitation programs must include exercise training, diet therapy, and lifestyle intervention, and should involve a multidisciplinary team including physical therapists, occupational therapists, health fitness programmers, dieticians and nurses. Clinical psychotherapists, medical technologists, and pharmacists should also be involved whenever necessary. Certified cardiac rehabilitation specialists should lead cardiac rehabilitation programs.

3. Roles of Nurses in Comprehensive Cardiac Rehabilitation

Class I

1. Patient education programs led by nurses are recommended as these programs are effective in modifying coronary risk factors. (**Level of Evidence: A**)

It has been reported that nurse-led management programs significantly decrease the morbidity and mortality of CAD.^{328–334}

There is an urgent need to foster specialists who manage cardiac rehabilitation programs, and nurses are expected to

Table 53. Typical Cardiac Rehabilitation Programs (Conditions for Reimbursement From NHI)

Item	Description
Duration	
Outpatient	1 hour/session (3 sessions)
Inpatient	≥1 hour/day
Supervision	A physician should supervise patients (or should be available at all times to healthcare professionals who are attending the session), and describe the progress of rehabilitation in patients' medical records.
No. of patients	
Inpatient	The number of patients supervised by a physician during a session is about 15, and that attended by a physical therapist or nurse is about 5.
Outpatient	The corresponding numbers are about 20 and 8.
No. of sessions provided	A healthcare professional excluding physician may provide ≤18 sessions a day and ≤108 sessions a week.
Calculation of NHI reimbursement	Fees for ECG, exercise ECG, and respiratory/pulse rate monitoring should be included in the fee for cardiac rehabilitation.
Documents required	<ul style="list-style-type: none"> - An integrated protocol* of "cardiovascular rehabilitation" (prepared once a month). Explain the progress of rehabilitation using the protocol* (at beginning and every 3 months thereafter). - Documents about rehabilitation (physician's instructions, exercise prescriptions, durations, contents of session, and supervisors), and exercise logs stamped by physicians, physical therapists, and nurses should be kept in the same file. - Multidisciplinary team should have conferences periodically to discuss the individual program.

*Refer to [Tables 54³²⁵](#) and [55³²⁵](#) for samples of rehabilitation protocols, and [Table 56³²⁶](#) for a sample of an integrated protocol.

NHI, National Health Insurance.

fulfil the role of cardiac rehabilitation instructors.

2. Cardiac Rehabilitation Programs and Disease Management After Discharge From Hospital

Class I

1. After discharge from hospital, it is recommended that all patients participate in cardiac rehabilitation programs to prevent recurrent cardiovascular events and improve prognosis. **(Level of Evidence: A)**
2. Maintenance-phase cardiac rehabilitation programs are effective in preventing recurrent cardiovascular events and improving QOL and prognosis, and are recommended for patients with cardiovascular diseases. **(Level of Evidence: A)**

Class IIa

1. It is appropriate that maintenance-phase comprehensive cardiac rehabilitation be continued for life. **(Level of Evidence: B)**
2. It is appropriate that disease management be continued for life. **(Level of Evidence: C)**

Class IIb

1. Cardiac rehabilitation only during hospitalization should be considered. **(Level of Evidence: B)**
2. Community-based cardiac rehabilitation programs are effective as maintenance-phase cardiac rehabilitation programs. **(Level of Evidence: B)**
3. Inappropriate work-rest balance and sleep disorders increase the risk of cardiovascular diseases. **(Level of Evidence: B)**

Cardiac rehabilitation programs after discharge from hospital consist of late phase II (outpatient recovery phase) and phase

III (maintenance phase) cardiac rehabilitation programs. Maintenance-phase cardiac rehabilitation programs serve as measures of secondary prevention of recurrent cardiovascular events, and of primary prevention of atherosclerotic diseases.

1. Late Phase II (Late Recovery Phase) Cardiac Rehabilitation

Late phase II cardiac rehabilitation programs are provided as ambulatory programs after discharge. As patients with cardiovascular diseases typically visit the clinic biweekly during the first 1~2 months after discharge for follow-up during this period, they should participate in comprehensive cardiac rehabilitation programs in which outpatient nurses play a central role in educating patients on smoking cessation, diet, and lifestyle interventions. In addition to education, patients should continue exercise training mainly consisting of endurance training, and undergo exercise stress tests at months 1 and 3 and at the end of the program to assess the efficacy of rehabilitation programs, predict prognosis, and reissue exercise prescriptions.

2. Phase III (Maintenance Phase) Cardiac Rehabilitation

Maintenance phase cardiac rehabilitation should be continued for life to prevent recurrent cardiovascular events. Cardiac rehabilitation becomes more effective as it continues, and it has been demonstrated that long-term cardiac rehabilitation programs significantly decrease total mortality and the rate of cardiovascular deaths.⁵

Exercise at the AT level is recommended in this phase. However, as patients in this phase have a broader margin of safety, the exercise intensity in the maintenance-phase rehabilitation programs may be set according to the maximum heart rate on maximal exercise stress tests using the Karvonen Formula.

Table 54. Rehabilitation Protocol

(Attached Form 21-4)
Rehabilitation Protocol
ID: _____ Date of assessment (Start date): _____

Name of patient: _____ M/F _____ Birth date: _____ (_____ years age)

Attending physician/Explained by:	Rehab physician:	Rehab nurse:
Physical therapist:	Other professionals (_____) involved:	

Diagnosis	Complications		
Hospitalized on:	Date of onset (approx.):		
Date of surgery:	Treatment (surgical) procedures		
Coronary risk factors (past illness)	☐ Hypertension ☐ Dyslipidemia ☐ Diabetes ☐ Hyperuricemia ☐ Chronic kidney disease (CKD) ☐ Obesity ☐ Smoking ☐ Old myocardial infarction ☐ Angina pectoris ☐ Family history ☐ Others:		

Risk during exercise	Cardiac function	☐ Normal ☐ Reduced (EF _____ %)	Limited range of joint motion	☐ Absent ☐ Present (_____)
	Arrhythmias	☐ Absent ☐ Present (_____)	Ischemia (residual stenosis)	☐ Absent ☐ Present (_____)
	Others			

Activities in the ward (currently conducted activities)	
Movement	☐ On the bed ☐ Using a wheelchair ☐ Walking in the room ☐ Walking in the ward ☐ Walking in the hospital ☐ Walking outdoors
Turning and positioning in bed	☐ Independent ☐ Supervised ☐ Supported *Remarks:
Walking (transferring)	☐ Independent ☐ Supervised ☐ Supported *Remarks: ☐ Independently ☐ Cane/walker ☐ Wheelchair ☐ Not performed yet ☐ Stretcher
Transfer from bed to wheelchair (stretcher)	☐ Independent ☐ Supervised ☐ Supported *Remarks: ☐ Not performed yet
Meals	☐ Independent ☐ Supervised ☐ Supported *Remarks: ☐ Not performed yet
Dressing	☐ Independent ☐ Supervised ☐ Supported *Remarks: ☐ IV line ☐ No IV line ☐ Others:
Urination	☐ Independent ☐ Supervised ☐ Supported *Remarks: ☐ Toilet for wheelchair ☐ Portable toilet ☐ Chamber pot ☐ Urinary catheter ☐ Others:
Defecation	☐ Independent ☐ Supervised ☐ Supported *Remarks: ☐ Toilet for wheelchair ☐ Portable toilet ☐ On the bed
Hygiene	☐ Independent ☐ Supervised ☐ Supported *Remarks: ☐ Bath ☐ Shower ☐ Shampoo ☐ Dry bath
Communication	☐ Communicable ☐ Somewhat difficult ☐ Difficult *Remarks:
Housing	☐ Living alone ☐ Living with others (_____) ☐ House ☐ Apartment
Occupation	☐ Unemployed ☐ Houseperson ☐ Office worker ☐ Physical worker
Goals to prevent recurrence and maintain health	☐ Understand the disease ☐ Compliance to drug treatment ☐ Dietary management ☐ Build exercise habit ☐ Improve physical strength ☐ Stop smoking ☐ Others:
Desire/goals of patients/family	

Goals/policy and contents of exercise programs (testing) (Checked items will be conducted stepwise)	
Start date (Day 1)	Planned duration
Goals/policy of exercise programs (stress test)	☐ Standing and walking around the bed ☐ 50m walking ☐ 100m walking ☐ 200m walking ☐ 500m walking ☐ _____ m walking ☐ Treadmill stress test ☐ Cycle ergometer test ☐ 6-minute walking test ☐ Others: *Remarks:
Exercise and prescription	☐ Respiratory training ☐ Stretching ☐ Muscle strengthening ☐ Activities of daily living ☐ Walking ☐ Cycling ☐ Others: *Exercise prescription:

I acknowledge that the above information was fully explained. Date: _____
 Signature of the patient or family member _____

Source: http://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryuu/iryuuoken/iryuuoken15/dl/2-22-5.pdf.³²⁵

3. Disease Management

Disease management programs for patients with cardiovascular diseases are provided to help patients modify their lifestyles

for better health for life through comprehensive programs. Such programs should be supported by family members, communities, and framework beyond the bounds of medical care

Table 55. Rehabilitation Protocol

(Attached Form 21-5) Rehabilitation Protocol			
ID	Name of patient	M/F	Birth Date:
Date of preparation:		(th protocol/Month)	
Diagnosis:		Understanding the measures to prevent recurrence and the needs for support and education	
Date of onset (approx.):	Date of surgery:	Self-pulse reading: ☐ Feasible ☐ Needs instruction	
Treatment (surgical) procedures:		Home blood pressure and weight monitoring: ☐ Conducting ☐ Needs support	
Complications:		Suitable exercises: ☐ Understand ☐ Currently practicing ☐ Needs support	
Coronary risk factors (past illness): ☐ Hypertension ☐ Dyslipidemia ☐ Diabetes ☐ Smoking ☐ Obesity ☐ Hyperuricemia ☐ Chronic kidney disease (CKD) ☐ Family history ☐ Angina pectoris ☐ Old myocardial infarction ☐ Other:		Appropriate type and amount of diet: ☐ Understand ☐ Currently practicing ☐ Needs support	
		Compliance to drug treatment: ☐ Understand ☐ Taking drugs as instructed ☐ Needs support	
		Management of prescribed drugs: ☐ By patient ☐ By family () ☐ Others ()	
		Anxiety about his/her disease: ☐ Absent ☐ Present	
Ideal body weight kg: Target blood pressure / mmHg	Anxiety about ADL and returning to work: ☐ Absent ☐ Present		
Current body weight kg: BMI kg/m ²	Leisure and social activities: ☐ Understand ☐ Currently practicing ☐ Needs support		
Current blood pressure (or home blood pressure) / mmHg	Sleeping: ☐ Good ☐ Poor [Difficulty in sleeping/ nocturnal awareness/ others:]		
		Tobacco: ☐ Quit ☐ Passive smoker ☐ Smokes (cigarettes/day) ☐ Needs support	
		Handling symptoms: ☐ Understood ☐ Needs support	
		(): ☐ () ☐ ()	
		(): ☐ () ☐ ()	
Laboratory findings		Multidisciplinary interventions to prevent recurrence	
☐ HbA1c (<6.5%) %		(Check the items for which the patient needs support and education)	
☐ LDL cholesterol (<100 mg/dL) mg/dL		☐ Exercise and ADL	
☐ HDL cholesterol (≥40 mg/dL) mg/dL		Name/role:	
☐ Triglycerides (≤150 mg/dL) mg/dL			
☐ BNP pg/mL			
☐ Others:			
Cardiac function:	Left ventricular ejection fraction (EF) [Normal/reduced] %		

(Table 55 continued the next page.)

to encourage patients to keep the necessary motivation to modify their lifestyle and behavior, maintain health, and ensure secondary prevention of recurrent cardiovascular events and primary prevention of new conditions.

To ensure successful long-term support, approaches to enhance the motivation of the participants, the continuous education by healthcare professionals, and the social support by communities are important.^{335,336} Specifically, there should be systems to provide individualized programs led by specialists with experience and expertise, useful indexes of exercise intensity and quantity, and non-hospital facilities for continued exercise training programs in communities.

4. Guidelines for ADL

High exercise capacity is a strong predictor of active daily living, high QOL, and favorable prognosis both in patients with cardiac disease and healthy individuals.³³⁷ Appropriate reference values should be used to assess exercise capacity. **Table 57**

shows the data recently published as reference values for exercise capacity expressed as the AT and peak VO₂ of people in Japan.³³⁸ Exercise capacity decreases linearly as a function of age, and is lower in women than in men. Oxygen uptake is smaller during cycle ergometer exercise than it is during treadmill ergometer exercise. In Japan, exercise intensity is most commonly estimated by METs. Recently, energy requirements of ADL and exercises for people in Japan were published (**Table 58**).³³⁹ In patients participating cardiac rehabilitation programs, exercise capacity should be assessed accurately using these reference data to prescribe appropriate exercise prescriptions.

(1) Instructions on ADL

Patients are recommended to perform aerobic exercise below the AT such as walking and cycling that use large muscles and are correspond to about 3–4 METs in healthy individuals. The MHLW proposed a unit for the amount of exercise (expressed

Other findings:	☐ Respiratory training ☐ Stretching ☐ Muscular strengthening ☐ ADL training ☐ Walking ☐ Cycling ☐ Others:
ADL ☐ Wheelchair (independent/pushed by others) ☐ Supported walking ☐ Cane walking ☐ Indoor walking only ☐ Outdoor walking ☐ Others:	☐ Meals Name/role:
Housing ☐ Living alone ☐ Living with others () Family support is [available/difficult] ☐ House [one-story/multiple-story building]	Comments:
☐ Apartment: Living on the th floor [with/without] elevator ☐ Others:	☐ Drugs Name/role:
Returning to work ☐ Unemployed ☐ Houseperson ☐ During medical leave ☐ Retired after onset ☐ Planning to retire ☐ Changed job ☐ Planning to change job ☐ Relocated after onset ☐ Return to the previous job - Job type/roles/how to commute:	Comments: ☐ () Name/role:
Desire/goals of patients/family	Comments:
Goals to prevent recurrence and maintain health ☐ Understand the disease ☐ Improve physical strength ☐ Dietary management ☐ Compliance to drug treatment ☐ Build exercise habit ☐ Stop smoking ☐ Others:	☐ () Name/role:
Results of exercise testing (exercise prescriptions) Exercise capacity [Improved/impaired] (% of healthy people: METs) Exercise prescriptions (pulse/blood pressure): bpm / mmHg Cycling: W minutes/session sessions/week Walking: km/h minutes/session sessions/week Precautions:	Continue exercise training programs ☐ in this hospital ☐ in home ☐ in other institutions: Planned tests and the duration of exercise training
	Name of the patient/family
	Physician: Physical therapist:
	Nurse: Other () specialists:

Source: http://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryoku/iryohoken/iryohoken15/dl/2-22-5.pdf.³²⁵

as Ex) in the Exercise Guide 2006 (“Exercise and Physical Activity Guide for Health Promotion 2006”) as a measure of energy consumption during exercise to take due account of the importance of energy consumption as well as exercise intensity (expressed as METs).^{103,340} The amount of exercise is expressed as the product of intensity and time of exercise, and may be used to calculate energy consumption during exercise.

[Formula for calculating the amount of exercise]

Amount of exercise (Ex)=Intensity of physical activities (METs)×Time (hours)

[Examples]

- Amount of exercise when physical activity corresponding to 3 METs is performed for 1 hour: 3 METs×1 hour=3 Ex (METs-hour)
- Amount of exercise when physical activity corresponding to 6 METs is performed for 30 minutes: 6 METs×1/2 hour=3 Ex (METs-hour)

[Formula to calculate the amount of energy consumed during exercise]

Amount of energy consumed during exercise (kcal)=1.05×Ex×body weight (kg)

The ACSM and the AHA recommend that healthy individuals perform moderate-intensity aerobic exercise for at least 30 minutes/session 5 days a week or high-intensity dynamic exercise for at least 20 minutes/session 3 days a week in addition to low-intensity exercise such as walking and housework in daily life. In addition to energy consumption during exercise, non-exercise activity thermogenesis (NEAT), the energy expenditure of all physical activities, such as housework, other than exercise, is gaining interest in preventing obesity.³⁴¹

Patients with impaired exercise capacity due to cardiac dysfunction such as MI should perform exercise at intensities lower than healthy individuals. Middle-aged and elderly patients with a high risk for cardiovascular and atherosclerotic

Table 56. Integrated Rehabilitation Protocol

(Attached Form 23-4) Integrated Rehabilitation Protocol			
ID	Name of patient	M/F	Returning to work ☐ Unemployed ☐ Houseperson ☐ During medical leave ☐ Retired after onset ☐ Planning to retire ☐ Changed job ☐ Planning to change job ☐ Relocated after onset ☐ Return to the previous job - Job type/roles/how to commute: - Leisure and social activities:
Birth Date: (years age)			Goals and approaches:
Date of assessment: (th time/ months after)			
Diagnosis:			Activities ☐ ADL ☐ Wheelchair (independent/pushed by others) ☐ Supported walking ☐ Cane walking ☐ Indoor walking only ☐ Outdoor walking ☐ Climbing stairs ☐ Others: ☐ Bathing ☐ Bathing ☐ Hip bath ☐ Shower ☐ Others: ☐ Communication ☐ Communicable ☐ Problematic: ☐ Others:
Date of onset (approx.): Date of surgery:			
Treatment (surgical) procedures:			
Complications:			
Coronary risk factors (past illness): ☐ Hypertension ☐ Dyslipidemia ☐ Diabetes ☐ Obesity ☐ Hyperuricemia ☐ Family history ☐ Smoking ☐ Chronic kidney disease (CKD) ☐ Angina pectoris ☐ Old myocardial infarction ☐ Others:			Goals and approaches:
Ideal body weight kg:			Housing ☐ Living alone ☐ Living with others () Family support is [available/difficult] ☐ House [one-story/multiple-story building] ☐ Apartment: Living in the floor [with/without] elevator ☐ Others:
Current body weight kg: BMI kg/m ²			
Target blood pressure / mmHg			
Current blood pressure (or home blood pressure) / mmHg			
Laboratory findings			Goals and approaches: Reconstruction/care devices [Necessary/unnecessary], Long-term care insurance system [Necessary/unnecessary]
☐ HbA1c % ☐ LDL-C mg/dL			
☐ HDL-C mg/dL ☐ Triglycerides mg/dL			
☐ Others:			Mental status - Anxiety about his/her disease: ☐ Absent ☐ Present (Specify:) - Anxiety about daily social activities: ☐ Absent ☐ Present (Specify:)

(Table 56 continued the next page.)

diseases should undergo exercise stress tests to assess exercise capacity and confirm the absence of cardiovascular dysfunction during exercise to ensure safe and effective exercise training programs.

5. Mental Stress, Sleep Disorders, and Returning to Work

(1) Life-Work Balance and Stress Control

Cardiovascular diseases are most commonly observed among middle-aged and elderly patients. Their social roles and busy lifestyle do not always induce strong mental stress, but rather often motivate them to live better and enjoy life. The loss experiences in old age may significantly affect mental function and cause depressive state and other psychological symptoms.³⁴² When stress control is considered for patients in this age group, physicians should encourage patients to build better work-rest balance rather than to quit or reduce work hours.

In a study of the relationship of work and sleeping hours with the incidence of AMI in Japan, the risk of AMI was 1.9 times higher in patients who worked ≥ 61 hours/week than those who worked ≤ 40 hours/week during 1 month. In another study of the relationship of short-term sleep with the incidence of cardiovascular diseases in Japan, a sleeping time of about < 6 hours/day was associated with a higher risk of cardiovascular diseases.³⁴³

Healthcare professionals should be aware that hardworking, high responsibility, perfectionistic, stubborn, and idealistic individuals tend to overwork and lose work-rest balance and therefore, they should encourage such individuals to rest appropriately and learn how to manage stress with techniques such as relaxation methods.

Women tend to suffer physical and mental disorders more commonly than men as women experience significant changes in hormone levels at different life stages such as menses, pregnancy, childbirth, and menopause; stress response also varies accordingly.^{344,345} In general, the prevalence of depression is higher in women than in men, although the incidence of suicide is higher in men (especially single men) than in women.

(2) Sleep Disorder

In addition to sleep shortage, many types of sleep disorders including insomnia increase the risk of cardiovascular diseases.³⁴⁶

Symptoms of insomnia include difficulty falling asleep, difficulty maintaining sleep, early morning awakening, and poor perceived quality of sleep, and may cause physical symptoms such as palpitation, shortness of breath, decreased weight, headache, dizziness, gastrointestinal disorder, back pain, stiff neck, and chronic fatigue, as well as psychological symptoms

Cardiac function ☐ Left ventricular ejection fraction (EF) [Normal/reduced] % ☐ Other findings:	- Sleeping: ☐ Good ☐ Poor [Difficulty in sleeping/nocturnal awareness/others:]
Physical function: ☐ Limited range of joint motion (Location:) ☐ Pain (Location:) ☐ Muscle weakness (Location:) ☐ Imbalance: ☐ Others:	- Appetite: ☐ Good ☐ Poor Goals and approaches:
Results of exercise stress tests (exercise prescriptions) Exercise capacity [Improved/impaired] (% of healthy people: METs)	Disadvantages to others (Effects of the patient's disease on the family's social activity, or health/mental status) ☐ Absent ☐ Present (Specify:)
Exercise prescriptions (pulse/blood pressure): bpm / mmHg Cycling: W minutes/session sessions/week Walking: km/h minutes/session sessions/week Precautions:	Goals and approaches: Presence/absence of supports for family members whose roles and social activities are affected.
Continue exercise training programs ☐ in this hospital ☐ in home ☐ in other institutions: Planned tests and the duration of exercise training Explained on: Name of the patient or family:	Goals to prevent recurrence, maintain health, and enhance recovery ☐ Understand the disease ☐ Enhance physical strength ☐ Dietary management ☐ Compliance to drug treatment ☐ Build exercise habit ☐ Quit smoking ☐ Others:
Physician: Physical therapist: Nurse: Other specialists ():	Understanding the measures to prevent recurrence and the needs for support and education - Self-pulse reading: ☐ Feasible ☐ Needs instruction - Home blood pressure and weight monitoring: ☐ Conducting ☐ Needs support - Suitable exercises: ☐ Understand ☐ Currently practicing ☐ Needs support - Appropriate type and amount of diet: ☐ Understand ☐ Currently practicing ☐ Needs support - Compliance to drug treatment: ☐ Understand ☐ Taking drugs as instructed ☐ Needs support - Management of prescribed drugs: ☐ By patient ☐ By family () ☐ Others: - Tobacco: ☐ Quit ☐ Passive smoker ☐ Smokes (cigarettes/day) ☐ Needs support - Coping with symptoms: ☐ Understood ☐ Needs support - (): ☐ () ☐ () ☐ ()
	The patient/family's desire:

Source: http://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryuu/iryuhoken/iryuhoken15/dl/2-22-7.pdf.³²⁶

such as loss of motivation, irritability, impaired concentration, and decreased attentiveness.³⁴⁷ Symptoms of insomnia also may impair recovery from fatigue and cardiovascular diseases, and may increase the risk of recurrent cardiovascular diseases.

Symptoms of sleep disorders are not limited to insomnia. Physicians treating patients with cardiovascular diseases should refer to guidelines for primary care physicians (Figure 13) or other appropriate materials or should collaborate with specialists.³⁴⁸

Symptoms of insomnia are effectively treated with drug treatment^{349,350} as well as mental therapy, such as cognitive behavioral therapy.³⁵¹ And patient education such as improving the patient's environment to ensure good sleep.

Sleep apnea syndrome and other SDB (See Section IV-5-3-2 "Patients with Sleep-Disordered Breathing Associated with Heart Failure") are important factors that exacerbate cardiac diseases. Physicians should follow up patients who return to work and assess their job situation and sleeping conditions.^{346,352}

(3) Management of Patients Who Have Returned to Work

Patients returning to work may have mental burdens as well as physical burdens. During absence from work, patients can easily get worried about whether they will be able to work as before, or whether can adjust to a new working environment (e.g., transfer to other sections), and tend to concern about not working, blame themselves for their disease. Physicians should give considerable attention to the patients who returned to work, since they tend to overwork in order not to give their colleagues further trouble.

3. Machines, Equipment and Facilities for Exercise Training

1. Machines for Exercise Training (Table 59)

Class I

1. It is recommended that facilities for exercise training be equipped with both aerobic exercise machines, such as tread-

Table 57. Exercise Capacity by Age (Years), Sex, and Mode of Exercise in Japanese People									
		20 s	30 s	40 s	50 s	60 s	70 s	SD	n
Cycle ergometer									
M	AT	19.5	18.4	17.4	16.4	15.4	14.4	3.41	285
	Peak $\dot{V}O_2$	36.8	34.1	31.4	28.7	25.9	23.2	6.35	272
F	AT	18.0	17.3	16.6	15.9	15.2	14.5	3.09	260
	Peak $\dot{V}O_2$	31.5	29.5	27.5	25.6	23.6	21.7	5.42	251
Treadmill									
M	AT	26.4	24.7	22.9	21.2	19.5	17.8	4.49	102
	Peak $\dot{V}O_2$	50.9	45.8	40.7	35.6	30.5	25.4	9.78	97
F	AT	20.8	20.1	19.4	18.7	18.0	17.3	3.11	102
	Peak $\dot{V}O_2$	36.5	34.4	32.3	30.2	28.2	26.1	5.20	93

AT, anaerobic threshold; F, female; M, male; peak $\dot{V}O_2$, peak oxygen uptake; SD, standard deviation.

Exercise capacity is expressed with the oxygen uptake at the AT and peak $\dot{V}O_2$ (mL/min/kg) estimated by age and sex, according to the regression analysis model described in: Itoh H, et al. Heart rate and blood pressure response to ramp exercise and exercise capacity in relation to age, gender, and mode of exercise in a healthy population. *J Cardiol* 2013; **61**: 71–78.³³⁸

Table 58. Energy Consumption During Activities of Daily Living and Exercises in Japanese People				
	Activities of daily living		Exercises	
		METs		METs
Low intensity (1.0–3.0 METs)	Office work	1.7±0.3	Stretching (standing)	1.6±0.3
	Sweeping	2.6±0.3	Stretching (sitting)	1.8±0.2
	Dishwashing	2.7±0.4	Resistance exercise (standing)	2.6±0.5
	Watering (using one hand)	2.9±0.4		
	Watering (using both hands)	3.0±0.4		
Moderate intensity (3.0–4.5 METs)	Vacuuming	3.2±0.4	3 km/h walking	3.1±0.5
	Hanging washed clothes	3.2±0.4	Resistance exercise (sitting)	3.2±0.4
	Mopping the floor	3.3±0.5	Aerobic exercise (standing)	3.4±0.8
	Pruning	3.5±0.7	4 km/h walking	3.7±0.3
	Cleaning the toilet	3.6±0.7	Aerobic exercise (sitting)	3.7±0.5
	Gardening	3.7±0.7		
	Spreading bedding	3.8±0.6		
	Putting bedding in a closet	3.9±0.6		
	Window cleaning	4.0±0.6		
	Weeding	4.1±0.3		
High intensity (≥4.5 METs)	Cleaning the bathroom	4.9±0.6	Radio taiso**	4.6±0.4
	Lawn mowing	5.0±0.3	Ping-pong	5.1±1.0
	A 4 km/h walking with a 5 kg load	5.1±1.0	6 km/h walking	5.3±0.6
	Plowing a field	5.3±1.0	Badminton	7.8±1.9
	A 4 km/h walking with a 10 kg load	5.5±1.0		
	Carry a heavy load*	6.5±1.1		
	Lifting stairs	6.9±1.0		

*(i.e., a case of 24 cans of 350 mL each)

** (a set of basic calisthenics common in Japan)

METs, metabolic equivalent units.

Adapted from Itoh H, et al. Heart rate and blood pressure response to ramp exercise and exercise capacity in relation to age, gender, and mode of exercise in a healthy population. *J Cardiol* 2013; **61**: 71–78,³³⁹ with modification.

mill or cycle ergometer, and resistance training devices, such as resistance training machine, dumbbells or weights.

(Level of Evidence: C)

- It is recommended that facilities for exercise training be equipped with ECG monitors, blood pressure monitors, automated external defibrillators (AEDs), and emergency carts. **(Level of Evidence: C)**

Class IIa

- A standard 12-lead ECG is not usually used during exercise training. However it is appropriate that a 12-lead ECG monitor is available in the first-aid room of each exercise training facility to use for patients who experienced chest pain. **(Level of Evidence: C)**

- It is appropriate that facilities for exercise training be equipped with simplified blood glucose monitors, percutaneous oxygen saturation monitors, and spirometry devices.

(Level of Evidence: C)

- It is appropriate that facilities for exercise training be equipped with video players, DVD players, personal computers, and projectors for patient education and also equipped with simplified pulse monitoring devices and Borg scale panel to monitor exercise intensity or ratings of perceived exertion. Physical activity monitoring devices and salt intake monitoring devices are also useful for management of patient's lifestyle. **(Level of Evidence: B)**

Table 59. Devices and Equipment Used in Rehabilitation Rooms**[Necessary]**

- Treadmill and cycle ergometers
- Resistance training devices
- ECG monitors, (automated) sphygmomanometers, and Borg scale panel
- AED, emergency carts, and oxygen delivery devices
- 12-lead ECG system
- Cardiopulmonary exercise testing devices (should be available in the hospital)

[Desirable]

- Personal computers for patient education, and DVD players
- Simplified pulse monitors, simplified salt intake measurement devices, simplified blood glucose monitors, and pulse oximetry (SpO₂ meters)

AED, automated external defibrillator; SpO₂, percutaneous arterial oxygen saturation.

(1) Equipment for Assessment of Physical Function

Graded exercise test, especially CPX with expiratory gas analysis, is useful in assessing exercise capacity. Skeletal muscle strength may be assessed based on one repetition maximum or isokinetic muscle strength.

(2) Equipment for Exercise Training

Treadmill or cycle ergometers are used in aerobic exercise training. Approximately 10 types of muscle training, including upper and lower extremity muscles, should be performed for resistance exercise training. The facility should be equipped with appropriate resistance training machines, weights, or other equipment. Pulse monitoring devices and accelerometers are

also useful in home-based exercise to monitor exercise intensity or physical activity.

(3) Vital Sign Monitors

During exercise, ECG, blood pressure, ratings of perceived exertion, and other parameters should be monitored. Although a 12-lead ECG is not necessary during exercise, it should be available in the first-aid room of training facilities to measure ECG in case of emergency.

(4) Equipment to Respond to Cardiac Events During Exercise

As cardiac events may occur during exercise training, facili-

ties for exercise training must be equipped with AEDs and emergency carts. Because patients are often complicated with diabetes or respiratory disorders, simplified blood glucose monitors and percutaneous oxygen saturation monitors must be available as well.

(5) Equipment for Lifestyle Modification

Cardiac rehabilitation programs compose salt restriction, smoking cessation, and nutritional modification. Salt intake measurement devices and home sphygmomanometers are useful for monitoring salt intake in salt restriction program, and information materials of healthy food such as nutritional supplements are useful in nutritional modification program.

X Future Prospects of Exercise Training

1. Collaboration With Local Facilities for Exercise Training: Current Situations and Future Prospects

1. Collaboration With Local Facilities for Exercise Training: Current Situations and Future Prospects

Cardiac rehabilitation, especially exercise training, should be continued after the patient leaves the hospital and returns to work. In Japan, medical institutions have tried to collaborate with non-profit organizations and private exercise facilities to develop systems for maintenance-phase cardiac rehabilitation, but no substantial results have been achieved.

(1) Governmental Activities Regarding Primary and Secondary Prevention of Cardiovascular Diseases

The government of Japan has not taken any particular measures for ensuring maintenance-phase cardiac rehabilitation, but has provided measures mainly for encouraging primary prevention of cardiovascular diseases such as the “first National Health Promotion Measures” in 1978, the “Active 80 Health Plan (the second National Health Promotion Measures)” in 1988, and the “Health Japan 21 (National Health Promotion in the 21st Century)” starting in 2000. These measures, proposed by the MHLW are taken to prevent the development of cardiovascular diseases among healthy individuals. However, the government has not proposed any health promotion measures for patients with cardiovascular diseases.

(2) Support of and Collaboration With Private Facilities for Exercise Training

It has been expected that maintenance-phase exercise programs be provided in existing health promotion facilities (e.g., fitness clubs, public gymnasiums, and healthcare facilities) and health promotion activities to help patients continue exercise training. However, there are a number of problems with this approach. For example, medical institutions and exercise facilities must develop appropriate methods to share patient information, and exercise facilities should be staffed with trained individuals capable of understanding patient medical information to provide appropriate exercise training programs. To solve these programs, medical institutions and health promotion facilities should build strong networks to educate health fitness programmers on cardiac rehabilitation and to provide and share information.^{353,354} In addition, a learning and certification system should be established to train qualified individuals to understand and provide appropriate exercise training as a secondary preventive measure for patients with cardiovascular diseases.^{355,356}

(3) Management of Facilities for Exercise Training in Medical Institutions

In Japan, medical institutions may have health promotion facilities that provide long-term training programs that is eligi-

ble for the healthcare costs deduction if the institutions meet the requirements of Article 42 of the Medical Service Act or are certified as designated facilities for exercise training.^{357–359}

2. Disease Management Through Hospital-Clinic Cooperation

(1) Community Collaborative Clinical Pathways and Cardiac Rehabilitation

Community collaborative clinical pathways are gaining attention as new, community-based disease management programs for patients with angina pectoris and MI. However, the problems are that cardiac rehabilitation programs after discharge from hospital are not emphasized and such pathways are reported to be not prevalent.^{360,361}

3. Ways to Continue Exercise Training

(1) Ways to Maintain Motivation

Although it is often difficult for individuals to continue exercise training for a long period of time, behavioral interventions to increase self-efficacy and develop self-management skills have been reported to be the most effective way to motivate patients with cardiac diseases.^{362–364}

(2) Community-Based Rehabilitation Programs

1) Community-Based Rehabilitation Programs in Other Countries

Community-based rehabilitation programs are popular in Germany and Scandinavian countries. In Germany, patients participate in community-based, training groups called ambulante Herzgruppe (AHG), and continue cardiac rehabilitation programs for life. The feature of AHG is that programs provided by AHG are covered by health insurance system in Germany. In Finland, public hospitals provide community-based cardiac rehabilitation programs targeting different cardiovascular diseases.³⁶⁵

In the United States, because cardiac rehabilitation programs are usually not covered by health insurances, various attempts have been made to develop cost-effective, community-based cardiac rehabilitation programs. One of such attempt is the INTERxVENT, a Web-based program.³⁶⁵

2) Community-Based Rehabilitation Programs in Japan (Figure 14)

Good relationships should be built between medical institutions and local facilities for exercise training to establish community-based cardiac rehabilitation programs in Japan.

Typical examples of community-based cardiac rehabilitation programs models are the Japan Heart Club (JHC), a non-profit organization (Figure 15), and the Japan Medical Fitness (JMF) network at Kansai Medical University.^{355,366,367}

(3) Home-Based Cardiac Rehabilitation Programs Using Information and Communication Technology (Figure 16)

Due to the advancement of programs using information and communication technology (ICT) such as the internet, ICT-based healthcare services (i.e., E-Health) have been introduced to provide information about health and diseases, conduct remote medical care, share health and medical information, and manage diseases, among others.

Recently, ICT-based lifestyle interventions have been attempted. In this system, data on body weight and step count are automatically sent to the central database when patients weigh themselves on a scale or wear pedometers.³⁶⁸ Physi-

cians and other attending individuals tasked to instruct patients may access to the database to monitor the body weight and step count of their patients. It has been demonstrated that ICT-based lifestyle interventions are beneficial helping the patient to reduce body weight, stop using tobacco, and continue exercise training programs.³⁶⁹⁻³⁷²

In Australia, the Australian e-Health Research Centre (AEHRC) is conducting a RCT of patients recovering from a MI, comparing an ICT-based cardiac rehabilitation program, in which all elements of cardiac rehabilitation (education, instruction, setting goals, and counseling) are enacted using mobile phones and the Internet, with a conventional home-based cardiac rehabilitation program.³⁷³

Figure 16. Example of remote exercise instruction/management system using information and communication technology (ICT).

2. Current Medical Service Fees for Cardiac Rehabilitation and Future Goals

1. Change Over Time in the Coverage of Cardiac Rehabilitation Programs by the Health Insurance System in Japan (Table 60)³⁷⁴

In the medical service fee revision in April 2010, diseases indicated for rehabilitation programs and fees for each disease category were listed (Table 61),³⁷⁵ and the criteria for medical institutions providing rehabilitation programs were revised (Table 62).³⁷⁵

The following points were revised in April 2010, and Table 63 lists remarks on medical service fees for “cardiovascular rehabilitation”.

1. In medical institutions providing “cardiovascular rehabilitation (I)”, cardiologists or cardiovascular surgeons were required to be available for 24 hours a day and 365 days a year before the revision, but are now required to be available during the period when rehabilitation sessions are conducted.
2. Physical therapists and nurses dedicated to “cardiovascular rehabilitation” may be involved in rehabilitation programs for other diseases during the period when they are not involved in “cardiovascular rehabilitation”.
3. Functional training rooms for cardiovascular rehabilitation may be used as rooms for rehabilitation for patients with other diseases, provided that the rooms meet the criteria for relevant rehabilitation rooms. When a healthcare professional dedicated to “cardiovascular rehabilitation” provides intergroup communication therapy and rehabilitation ses-

sions to patients with cardiovascular diseases and to other patients, he or she may provide a total of around 18 service units/day and ≤ 108 service units/week per physician, where 1 service unit is defined as a 20-minute service in terms of “cardiovascular rehabilitation”.

4. When a patient with cardiovascular diseases starts rehabilitation during hospitalization, services during the first 30 days of rehabilitation are subjected to “early-phase rehabilitation premium” with a NHI reimbursement of 45 points per service unit, which was 30 points before the revision.
5. A NHI premium of 100 points was introduced for “continuous respiratory gas analysis” during CPX to prescribe appropriate exercise prescriptions.

The indications for “cardiovascular rehabilitation” were expanded to include patients with AMI, those with angina pectoris, those who have undergone open heart surgery, those with a large vessel disease (aortic dissection, dissecting aortic aneurysm, or after large vessel surgery), those with chronic heart failure, and those with peripheral arterial occlusive disease, among others. In the medical service fee revision in April 2012,³⁶⁵ the following changes were made for the criteria of medical institutions providing cardiovascular rehabilitation (Table 62).³⁷⁵

1. The “early-phase rehabilitation premium” was reduced from 45 points to 30 points, and the “initial phase premium” of 45 points was newly set for rehabilitation services during the first 14 days. With this revision, the NHI reimbursement of “cardiovascular rehabilitation” during the first 14 days is increased to a total of 75 points per unit consisting of 30 points of the “early-phase rehabilitation premium”

Table 60. Changes Over Time in NHI Reimbursement for Cardiovascular Rehabilitation in Japan

1988	Cardiac rehabilitation was included in the NHI reimbursement list (as “fees for physical therapy for cardiac disease”, covering only patients after acute myocardial infarction during the first 3 months, 335 points).
1992	The title was changed to “fees for cardiac rehabilitation”, and the point value was increased (335→480 points).
1996	The approval point value was increased (480→530 points), duration was extended (3→6 months), and indications were expanded (patients with acute myocardial infarction, those with angina pectoris, and those who had undergone open heart surgery).
1998	The point value was increased (530→550 points).
2004	The criteria for hospitals providing cardiac rehabilitation were relaxed to exclude the criterion “hospitals should satisfy the requirement for hospitals that can claim fees for designated ICU treatment or fees for critical care treatment”.
2006	Fees for disease-specific rehabilitations were introduced, and the fees for cardiovascular rehabilitation in the approved facilities category I and II were set at 250 points/20 minutes and 100 points/20 minutes, respectively. Namely, the point value for a standard 60-minute session was increased for category I (550→750 points) and decreased for category II (550→300 points). The duration covered was decreased from 6 months to 150 days.
2007	The criteria for patients for whom the fees for rehabilitation are covered by NHI without limitation were defined. The fee for rehabilitation and medical management was newly introduced. Disease-specific rehabilitation fees were revised. A step-down pricing policy was introduced.
2008	Disease-specific rehabilitation fees were revised. The fees for category I were changed from 250 to 200 points/20 minutes, while the fees for category II were unchanged at 100 points/20 minutes. The fee for a 60-minute session was changed from 750 to 600 points for category I and was unchanged at 300 points for category II. The fee for rehabilitation and medical management, the step-down pricing policy, and the maximum duration of NHI coverage were abolished. The indications were extended to include large vessel diseases (patients with aortic dissection, those with dissecting aortic aneurysm, and those who had undergone large vessel surgery), chronic heart failure, and peripheral arterial occlusive disease in addition to the existing indications of those with acute myocardial infarction, those with angina pectoris, and those who had undergone open heart surgery. An early-phase rehabilitation premium was introduced for the first 30 days of rehabilitation (30 points).
2010	In hospitals providing rehabilitation after heart or large vessel diseases, physicians providing cardiovascular or cardiovascular surgery services are no longer required to be available for 24 hours a day and 365 days a year. The requirement for physical therapists responsible for rehabilitation in patients with cardiovascular diseases, but who had not been allowed to be responsible for or dedicate to other categories of rehabilitation, were changed to allowed them to provide rehabilitation sessions for patients with other diseases. The term to define the area used for functional training was changed from “room” to “space” to ease the requirement for the location of functional training. The early-phase rehabilitation premium was increased from 30 to 45 points. A premium of 100 points was introduced for continuous respiratory gas analysis during cardiopulmonary exercise testing.
2012	The early-phase rehabilitation premium was decreased from 45 to 30 points. The initial phase premium (45 points) was introduced for the first 14 days. During the first 14 days, the point value was increased to 75 points (30 points for the early-phase rehabilitation premium and 45 points for the initial phase premium), which was higher in the previous version (45 points). The NHI reimbursement list added samples of protocols for inpatients and outpatients and summarized protocols for cardiovascular rehabilitation.*

*See Tables 54–56. 1 point=10 yen. NHI, National Health Insurance.

Adapted from Kohzuki M. Cardiac rehabilitation and health insurance treatment. *Junkanki Naika* 2011; **69**: 267–274,³⁷⁴ with modification.

Table 61. NHI Reimbursement for Disease-Specific Rehabilitation

	Cardiovascular rehabilitation	Musculoskeletal rehabilitation	Pulmonary rehabilitation	Rehabilitation after cerebrovascular diseases or other diseases (disuse syndrome)
Typical indications	Acute myocardial infarction, angina pectoris, recovery from open heart surgery, large vessel diseases, chronic heart failure, and peripheral arterial occlusive diseases, among others	Extremity trauma, recovery after surgery for fractures, and joint contracture due to burn scar, among others	Pneumonia or atelectasis, and Grade II or severer chronic obstructive pulmonary disease, among others	Cerebrovascular diseases, and brain injury, among others
Rehabilitation fees (I) Points per 1 unit (20 minutes)	200	175	170	245 (235)
Rehabilitation fees (II) Points per 1 unit (20 minutes)	100	165	80	200 (190)
Rehabilitation fees (III) Points per 1 unit (20 minutes)		80		100 (100)
Standard maximum length of NHI coverage	150 days	150 days	90 days	180 days

Source: Notifications from the Medical Economics Division, Health Insurance Bureau, MHLW regarding the revision of NHI reimbursement list in 2012. URL: http://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryou/iryohoken/iryohoken15/index.html, last accessed on April 24, 2012.³⁷⁵

MHLW, Ministry of Health, Labor and Welfare; NHI, National Health Insurance.

Table 62. Requirements for Medical Institutions Providing Cardiovascular Rehabilitation

Disease group	Cardiovascular rehabilitation (I)	Cardiovascular rehabilitation (II)
Physicians	This service should be provided in insurance authorized medical institutions where cardiologists or cardiovascular surgeons are working full time during the period when cardiovascular rehabilitation is provided, and at least one physician who has experience in and is responsible for cardiovascular rehabilitation is working. The medical institutions should have appropriate systems to communicate with the responsible physicians when a sudden change in a patient's condition occurs during rehabilitation, and to treat the patient appropriately in the institution or affiliated NHI-covered institutions.	This service should be provided in medical institutions where at least one experienced full-time physician is working (Patients with stable condition may conduct rehabilitation sessions without direct supervision by a physician).
Healthcare professionals	This service should be provided in medical institutions where a total of ≥ 2 full-time physical therapists and/or full-time nurses who have experience in and are dedicated to cardiovascular rehabilitation are working. One of the two staff members may be a member who is responsible for the service. The above-mentioned staff members may not work as staff members in the recovery-phase rehabilitation ward, but may provide rehabilitation sessions for patients with other diseases, disabled children/patients, or patients with cancer during the time when they are not involved in cardiovascular rehabilitation. The staff members may also be registered as being dedicated to other types of rehabilitation when different rehabilitation programs are scheduled on different days and times.	This service should be provided in medical institutions where ≥ 1 physical therapist or nurse who is experienced in and is dedicated to cardiovascular rehabilitation is working. The above-mentioned staff members dedicated to this service may not work as staff members in the recovery-phase rehabilitation ward, but may provide rehabilitation sessions for patients with other diseases, disabled children/patients, or patients with cancer during the time when they are not involved in cardiovascular rehabilitation. The staff members may also be registered as being dedicated to other types of rehabilitation when different rehabilitation programs are scheduled on different days and times.
Criteria for medical institutions	The medical institutions should have a room dedicated to functional training with an area of $\geq 30\text{ m}^2$ in hospitals and $\geq 20\text{ m}^2$ in clinics. The room dedicated for functional training may be used for other purposes during the time when the relevant service is not provided. Functional training rooms for cardiovascular rehabilitation may be used as rooms for rehabilitation for patients with other diseases, disabled children/patients or cancer patients, provided that the rooms meet the criteria for relevant rehabilitation rooms. For example, when cardiovascular and cerebrovascular rehabilitation are provided simultaneously, the functional training room should be larger than the sum of the areas specified in the relevant criteria and should be equipped with devices and instruments dedicated for the relevant rehabilitation services.	Same as on the left.
NHI reimbursement	200 points Rehabilitation during hospitalization is subject to the early-phase rehabilitation premium (30 points/unit) during the first 30 days, and the initial phase premium (45 points/units) during the first 14 days of rehabilitation.	100 points Rehabilitation during hospitalization is subject to the early-phase rehabilitation premium (30 points/unit) during the first 30 days, and the initial phase premium (45 points/units) during the first 14 days of rehabilitation.
Maximum duration of NHI coverage	150 days	150 days

*Direct supervision by a physician is required for patients with high-risk arrhythmias, patients with cardiac dysfunction, and patients with exercise-induced ischemia.

Source: Notifications from the Medical Economics Division, Health Insurance Bureau, MHLW regarding the revision of NHI reimbursement list in 2012. URL: http://www.mhlw.go.jp/seisakunitsuite/bunya/kenkou_iryou/iryohoken/iryohoken15/index.html, last accessed on April 24, 2012.³⁷⁵

MHLW, Ministry of Health, Labor and Welfare; NHI, National Health Insurance.

and 45 points of the “initial phase premium”. This revision encourages healthcare professionals to start rehabilitation earlier (Figure 17). These premiums are available in “medical institutions where rehabilitation physicians belong”, and the definition of “rehabilitation physicians” is discussed in detail in Office Communication of the Medical Economics Division, Health Insurance Bureau, MHLW dated March 30, 2012. Please refer to it. It should be noted that these premiums are applied to rehabilitation services in medical institutions where at least one physician dedicated to rehabilitation is working on a regular basis even if such medical institutions have not notified the prefectural government that they will provide rehabilitation services. Cardiovascular rehabilitation is covered with the NHI premiums in medical institutions providing cardiovascular or cardiovascu-

lar surgery services in which at least one full-time physician is experienced in “cardiovascular rehabilitation”. Accordingly, hospitals satisfying the criteria for medical institutions providing cardiovascular rehabilitation may claim the above-mentioned NHI premiums.

2. The NHI reimbursement added samples of “cardiovascular rehabilitation protocol for inpatients (Attached Form 21-4)” (Table 54),³²⁵ “cardiovascular rehabilitation protocol for outpatients (Attached Form 21-5)” (Table 55),³²⁵ and “integrated cardiovascular rehabilitation protocol (Attached Form 23-4)” (Table 56)³²⁶ to facilitate healthcare professionals in developing cardiovascular rehabilitation programs.

Table 63. General Remarks for Fees for Cardiovascular Rehabilitation**1. Equipment and system**

- (1) Rooms dedicated for functional training should be equipped with necessary devices and instruments, i.e., defibrillators, ECG monitors, treadmill or ergometer machines, blood pressure monitors, and emergency carts. Cardiopulmonary exercise testing devices should be available in the hospital providing the service.
- (2) Records about rehabilitation sessions (e.g., physician's directions, exercise prescriptions, duration and contents of rehabilitation, and a list of responsible staff members) should be managed in an integrated fashion for each patient and should be accessible by healthcare professionals.
- (3) Multidisciplinary case conferences should be held regularly.
- (4) The hospital should manage emergency situations occurring during rehabilitation. Specifically, emergency surgery and emergency angiography should be available in the hospital providing the service or affiliated medical institutions providing NHI-covered cardiovascular or cardiovascular surgery services. The hospital providing the service or affiliated medical institutions should be registered as medical institutions that may claim fees for critical care treatment and fees for designated ICU treatment.

2. Standard length of session of cardiovascular rehabilitation and the number of patients per staff member

Rehabilitation sessions should be conducted under instruction and control by a physician responsible for the service. The physician should directly supervise patients, or should be in the hospital and communicable to staff members directly supervising patients and should be able to respond to emergency situations without delay. The length of a standard session is about 1 hour (3 units). Outpatients should conduct rehabilitation 3 hours (9 units) per week as sessions of ≥ 1 hour (3 units) as a standard menu. The numbers of inpatients supervised by a responsible physician, physical therapist and nurse during a session should be about 15, 5 and 5, respectively, and those of other patients should be about 20, 8 and 8, respectively. When a healthcare professional dedicated to "cardiovascular rehabilitation" provides rehabilitation sessions to patients with cardiovascular diseases and to other patients, he or she may provide a total of 18 service units per day and ≤ 108 service units per week, where 1 service unit is defined as a 20-minute service in terms of cardiovascular rehabilitation.

3. Fees for examination conducted during rehabilitation should be included in the fees for cardiovascular rehabilitation.

The NHI reimbursement for cardiovascular rehabilitation include fees for conducting ECG examination, exercise ECG, heart/respiratory rate monitoring, heart/respiratory rate monitoring in newborn infants, cardioscope (heart scope), and cardiotoscope that are conducted during rehabilitation sessions.

4. The NHI covers ≤ 13 units/month of maintenance-phase rehabilitation

For patients in whom continued rehabilitation is considered medically appropriate, the NHI covers ≤ 13 units/months of maintenance-phase rehabilitation after the standard maximum duration of NHI-covered rehabilitation.

5. The service may be provided after the standard maximum duration of NHI-covered rehabilitation.

Patients indicated for cardiovascular rehabilitation may continue rehabilitation after the maximum duration of NHI-covered rehabilitation when continued rehabilitation is expected to improve the patient's condition on a medical basis and when appropriate documents containing necessary descriptions are submitted.

ICU, intensive care unit; NHI, National Health Insurance.

3. The Future of Cardiac Rehabilitation From the Health Economics Viewpoint

Introduction

This section discusses the health economic value of cardiac rehabilitation, and provides basic information for further socioeconomic consideration of comprehensive cardiac rehabilitation. Because the benefits of cardiac rehabilitation in micro are discussed in earlier sections, this section mainly discuss cost-effectiveness and benefits of cardiac rehabilitation for macro. This section first describes the health-economic evidence of the benefits of comprehensive cardiac rehabilitation in micro with CAD and other cardiovascular diseases, and then lists cases in foreign countries (although not sufficient to serve as evidence) as examples of the effects of cardiac rehabilitation on the health insurance resources and industries in the society.

1. Health-Economic Effects of Exercise Training on Micro Class I

1. Long-term exercise intervention improves well-being of patients (utility value and life years), and reduces healthcare cost. (**Level of Evidence: A**)

Class IIa

1. Long-term exercise intervention improves the balance between benefits and burdens (cost-effectiveness) of patients and family members. (**Level of Evidence: B**)

2. Exercise intervention for less than 12 months improves the well-being of patients (utility value and life years) and reduces healthcare cost. (**Level of Evidence: C**)

Class IIb

1. Exercise intervention for less than 12 months improves the balance between benefits and burdens (cost-effectiveness) of patients and family members. (**Level of Evidence: C**).

In a study on the health-economic performance of cardiac rehabilitation for 10 years, the cost required to gain an additional life-year is US \$806 among patients undergoing cardiac rehabilitation, which is lower than the US \$1,073 required for patients without cardiac rehabilitation (Table 64).³³⁵ In another study where the cost-effectiveness of a 14-month exercise training program in patients with stable chronic heart failure, the cost required to gain an additional life-year was higher in patients with cardiac rehabilitation than in those without it. These findings indicated that longer exercise training is more cost-effective.³⁷⁶

In a study of the cost-effectiveness of cardiac rehabilitation in secondary prevention of cardiovascular diseases using the cost-utility analysis, the cost utility was US \$640 saved per quality-adjusted life-year (QALY) gained, which indicates that cardiac rehabilitation may reduce healthcare costs and improve QALY compared to usual care (without cardiac rehabilitation).³⁷⁷

Figure 17. Relationship between the early-phase rehabilitation premium and the initial phase premium for disease-specific rehabilitation.

Table 64. Estimated Cost-Effectiveness of Cardiac Rehabilitation			
Groups	Study	Georgiou (n=99)	Inglis (n=297)
	Duration	14 months	10 years
Patients undergoing cardiac rehabilitation	Total cost	5,282	3,267
	Additional life-years	10.2	4.1
	(US \$)/life year	515.8	806.7
Patients without cardiac rehabilitation	Total cost	2,055	3,059
	Additional life-years	8.0	2.9
	(US \$)/life year	258.2	1,073.3

Source: Inglis SC, et al. Extending the horizon in chronic heart failure: effects of multidisciplinary, home-based intervention relative to usual care. *Circulation* 2006; **114**: 2466–2473.³³⁵ and Georgiou D, et al. Cost-effectiveness analysis of long-term moderate exercise training in chronic heart failure. *Am J Cardiol* 2001; **87**: 984–988.³⁷⁶

Table 65. Effects of Cardiac Rehabilitation on Patient’s Returning to Work			
Results	% returning to work		P value
	Rehabilitation participants (n=96)	Matched controls (n=156)	
Returning to work within 3 months	53.1	34.8	0.001
Returning to work after 3 months	10.4	7.1	
Returning to work within 3 months but stopped working within 1 year	19.9	31.0	
Never returning to work	16.7	27.1	

Source: Simchen E, et al. Is participation in cardiac rehabilitation programs associated with better quality of life and return to work after coronary artery bypass operations? *Isr Med Assoc J* 2001; **3**: 399–403.³⁷⁹

2. Health-Economic Benefits of Exercise Training on Macro Class I

None.

Class IIa

1. Exercise intervention over a period of time is expected to help patients return to work and increase labor productivity. (**Level of Evidence: B**)
2. Exercise intervention over a period of time alleviates the financial burden on community healthcare insurance systems and improves the management efficiency of medical institutions. (**Level of Evidence: C**)

Class IIb

1. Exercise intervention saves health insurance resources, reduces the financial burden on insurers and society, and improves the economic performance (cost-effectiveness) of the health care system. (**Level of Evidence: C**)

Studies on the effect of cardiac rehabilitation on the health insurance resources have demonstrated that the healthcare

costs for patients undergoing comprehensive cardiac rehabilitation was significantly lower than those for patients without it, and suggested that cardiac rehabilitation may help reduce healthcare costs of the whole country. In a study in the United States, cardiac rehabilitation resulted in a gross cost savings of US \$956 per patient (US \$159/patient per month) during 6 months, and US \$1,863 per patient during 36 months (US \$52/patient per month).³⁷⁸

In another study of the effect of cardiac rehabilitation programs on work productivity in patients after CABG, patients who participated in cardiac rehabilitation programs for 3–6 months returned to work earlier than those without cardiac rehabilitation (the percentage of patients returning to work within 3 months was 53.1% vs. 34.8%, respectively), and the percentages of patients who were rehospitalized and of those who stopped work after initially going back to work were lower in those with, than in those without, cardiac rehabilitation (**Table 65**).³⁷⁹ Sufficient studies have not been conducted on the effects of cardiac rehabilitation on industries. Further studies such as those using the methods of Input-Output analysis should be performed in the future.

XI Conclusion

This abbreviated guidelines contain a list of recommendations with a class of recommendation and a level of evidence in accordance with other guideline documents published by the JCS. Currently, there is insufficient evidence to make recommendations on cardiac rehabilitation worldwide. The lack of evidence is a serious problem, especially in Japan where evidence from multicenter clinical studies is limited and relies on foreign data. The NHI reimbursement for cardiac rehabilitation has been changed almost every year, but the importance of cardiac rehabilitation has not been fully understood or recognized, and the government has not provided a sufficient budget for this area. We hope this guideline will help cardiologists,

nurses, and other healthcare professionals provide appropriate cardiac rehabilitation programs for their patients. In this revision, we describe in detail the health-economic benefits of cardiac rehabilitation, and the change over time in the coverage of cardiac rehabilitation programs by the national insurance system, to encourage the usage of cardiac rehabilitation in the clinical setting. Because the NHI reimbursement is revised every year and recommendations will become outdated, we are seeking a way to provide up-to-date information. We expect that many healthcare professionals will understand and utilize this guideline document in the clinical setting and lead the advance of cardiac rehabilitation in Japan.

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Appendix

Chair:

- Ryuji Nohara, Hirakata Kohsai Hospital

Members:

- Hitoshi Adachi, Department of Cardiology, Gunma Prefectural Cardiovascular Center
- Yoichi Goto, Department of Cardiovascular Medicine, National Cerebral and Cardiovascular Center
- Emiko Hasegawa, Department of Human Welfare, Seigakuin University
- Shunichi Ishihara, Bunkyo University, Faculty of Human Sciences
- Haruki Itoh, Sakakibara Heart Institute
- Yutaka Kimura, Health Science Center, Kansai Medical University Hirakata Hospital
- Kazuhira Maehara, Shirakawa Kosei General Hospital
- Shigeru Makita, Department of Cardiac Rehabilitation, Saitama International Medical Center, Saitama Medical University

- Hiroshi Matsuo, Matsuo Clinic
- Shin-ichi Momomura, Cardiovascular Medicine, Jichi Medical University Saitama Medical Center
- Haruki Musha, Department of Sports Medicine, St. Marianna University School of Medicine
- Masatoshi Nagayama, Department of Cardiology, Sakakibara Heart Institute
- Takeshi Nakatani, Department of Transplantation, National Cerebral and Cardiovascular Center
- Tomoyuki Takura, Department of Health Care Economics and Industrial Policy, Osaka University Graduate School of Medicine
- Kenji Ueshima, Department of EBM Research, Institute for Advancement of Clinical Research and Translational Science, Kyoto University Hospital
- Ken Watanabe, Department of Pediatrics, Kitano Hospital
- Sumio Yamada, Department of Rehabilitation Science, Nagoya University Graduate School of Medicine

- Akira Yamashina, Department of Cardiology, Tokyo Medical University Hospital

Collaborators:

- Toshimi Ikegame, St.Luke's International Hospital Branch Clinic St. Luke's Medilocus
- Masahiro Kohzuki, Department of Internal Medicine and Rehabilitation Science, Tohoku University Graduate School of Medicine
- Eisaku Nakane, Heart Center, Kitano Hospital
- Hideki Origuchi, Department of Internal Medicine, Kyushu Kosei Nenkin Hospital
- Shinji Sato, Department of Sports and Health Science, Osaka Sangyo University
- Tetsuya Takahashi, Department of Physical Therapy, Tokyo University of Technology
- Katsutoshi Tanaka, Department of Occupational Mental Health, Kitasato University Graduate School of Medical Sciences
- Nozomi Tanaka, Heart Center, Kitano Hospital
- Toshiko Yoshida, Miyagi University School of Nursing

Independent Assessment Committee:

- Nobutaka Doba, The Life Planning Center Foundation
- Tohru Izumi, Kojinkai Niigata Minami Hospital
- Hirofumi Kambara, Shizuoka General Hospital
- Muneyasu Saito, Saitama Memorial Hospital
- Chuwa Tei, Waon therapy research institute/Dokkyo Medical University

(The affiliations of the members are as of July 2013)