Forefront of Cardiac Rehabilitation in Japan

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Cardiac rehabilitation refers to a long-term, multifaceted, comprehensive program designed to optimize a patient’s physical, psychological, social, and vocational status. In addition, it stabilizes, slows, or even reverses the progression of the underlying atherosclerotic or heart failure processes, thereby reducing recurrence, rehospitalization, and mortality and enabling patients to live comfortably and actively. Cardiac rehabilitation programs include “medical assessment, prescribed exercise training, coronary risk factor modification, patient education, counseling and optimal medical therapy” for individual patients, provided efficiently by a multidisciplinary team.

The mission of cardiac rehabilitation is to

1) Avoid unnecessary bed rest and proceed with safety exercise and mobilization in the acute phase.
2) Promote reintegration into the workplace and society in the recovery phase.
3) Prevent recurrence and aggravation of disease in the recovery and maintenance phases.
4) Prevent and overcome frailty, which strongly affects the prognosis.

**Early cardiac rehabilitation (Phase I)**

After cardiac surgery, cardiac rehabilitation is performed as early as possible to ensure the recovery of physical function and prevent perioperative complications\(^\text{2}\). A study of the Cardiovascular Surgery Physiotherapy Network (CPN), a multicenter database of physiotherapy after cardiac surgery (with the author as principal investigator) found that the average number of days to regain the ability to walk after cardiac surgery was 3.8 days\(^\text{2,3}\). Many patients at the Juntendo University Hospital can also walk independently within 3 days after cardiac surgery. Furthermore, the efficiency of rehabilitation seems to be advanced. Prompt recovery of walking ability to the same level as before surgery is desirable because it leads to early discharge from the hospital.

On the contrary, in rehabilitation, the characteristics of patients who could not walk independently after surgery should be determined and measures to prevent the deterioration of physical functions should be taken. Moreover, it is important to be aware of the medium- and long-term rehabilitation, such as daily life and return to society after discharge, at the start of the short hospitalization period.

The CPN research group reported on the characteristics of patients whose rehabilitation did not proceed smoothly after cardiac surgery (8.6–10.6%)\(^\text{2–4}\) due to prolonged postoperative heart failure, occurrence of postoperative arrhythmias, preoperative decline of motor function, acute postoperative renal injury, and postoperative neuro- logical deficits\(^\text{5–6}\). More recently, postoperative atrial fibrillation delays early rehabilitation and increases the risk of functional decline of the lower extremity during hospitalization\(^\text{7}\); preoperative low body weight is associated with significant postoperative motor function decline\(^\text{8}\); in older patients, age, preoperative estimated glomerular filtration rate (eGFR), and preoperative walking speed are associated with physical functional decline after cardiac surgery\(^\text{9}\); and preoperative frailty affects the ability to walk again after cardiac surgery, which is indicated by the preoperative SPPB cutoff value of 9 or more\(^\text{10}\).

Factors that delay rehabilitation after cardiac surgery are listed in Table-1. Age, renal dysfunction, arrhythmia, emergency surgery, and prolonged heart failure increase the length of stay in the intensive care unit (ICU) and are strongly associated with subsequent rehabilitation progression\(^\text{11–14}\). Patients who underwent postoperative cardiac surgery and stayed in the ICU for a long period have reduced exercise tolerance and ADL capacity after discharge from the hospital\(^\text{14}\), thus requiring careful rehabilitation while closely monitoring the changes in their condition.

The Japan Society of Intensive Care Medicine published an expert consensus “Evidence-based expert consensus for early rehabilitation in the intensive care unit” in February 2017\(^\text{15}\), indicating the contraindications (Table-2), and inception and cessation criteria for early rehabilitation (Table-3, 4) including consciousness, pain, respiration, circulation, and others, with clear thresholds. Thus, the same criteria can be used to initiate and advance the exercise load even when there is a change in medical professions\(^\text{16}\).

Owing to this early rehabilitation expert consensus, “early rehabilitation addition (5,000 yen/patient/day, 14-day upper limit)” was newly established as an additional fee for the specific ICU management in the revision of medical treatment fees in FY2018. A claim for reimbursement of disease-specific

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Table 1: Factors delaying rehabilitation after cardiac surgery

| Factor                                      |
|---------------------------------------------|
| Old age                                    |
| Emergency surgery                          |
| Surgical invasion                          |
| Preoperative frailty                       |
| Preoperative decline in renal function     |
| Cognitive decline before surgery           |
| Underweight before surgery                 |
| Preoperative low nutrition                 |
| Prolonged heart failure after surgery       |
| Postoperative arrhythmia (particularly, atrial fibrillation) |
| Postoperative acute kidney injury          |
| Postoperative neurological disorders        |
| Postoperative delirium                     |
| Prolonged ventilator weaning after surgery  |
| Low FSS–ICU score before ICU discharge      |

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rehabilitation fees could not be approved because "a patient receiving intensive care in an intensive care unit is in no condition to be rehabilitated due to a serious illness.” Thus, early mobilization and rehabilitation in ICUs have become an established position in the Japanese medical insurance system.

Early mobilization and rehabilitation after cardiac surgery reduce postoperative complications, improve physical function, shorten hospital stay, and improve sleep status. Juntendo University Hospital actively performs early mobilization and rehabilitation in patients with cardiac disease. After cardiovascular surgery, it takes an average of approximately 3 days for patients to walk independently in the general ward.

Rapidly increasing numbers of older patients with heart failure

While many patients with cardiac diseases...
recover well with early mobilization and rehabilitation programs, older patients with severe cardiac conditions experience delayed recovery. This is, however, common among older patients who lived alone before the onset of heart disease, and their physical function deteriorates to the point where they are unable to live on their own due to disuse syndrome caused by rest during treatment and hospitalization.

In such cases, in addition to traditional cardiac rehabilitation programs aimed at increasing walking distance, a physical therapy program to improve physical function and rebuild a usual life is needed. In general, older patients with heart failure have specific characteristics such as sluggish movement (slowness), low physical fitness (frailty), and impaired balance function, which then paradoxically require assessment in order to create an exercise therapy to improve low-scoring function. For older patients, in addition to confirming the

### Table 4 Cessation criteria for early mobilization and rehabilitation

| Category                  | Items and index                          | Criteria for determination                                                                 | Remarks                                      |
|---------------------------|------------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------|
| Nervous system            | • Reaction                                | • Appearance of a clear bad reaction condition                                               | • A state of drowsiness and chaos against a call |
|                           | • Facial expression                       | • Appearance of agonizing expressions, facial paleness, and cyanosis                       |                                             |
|                           | • Consciousness                          | • Emergence of mild or more consciousness disorders                                        |                                             |
|                           | • Agitation                              | • Emergence of dangerous behavior                                                         |                                             |
|                           | • Voluntary movement of the extremities  | • Emergence of limb weakness                                                              |                                             |
|                           | • Postural adjustment                    | • Rapid increase in the amount of assistance                                               |                                             |
|                           | • Fall                                   | • Emergence of unretained posture                                                         |                                             |
| Subjective symptoms      | • Dyspnea                                | • Complaint of sudden dyspnea                                                              | • Pneumothorax                              |
|                           | • Fatigue                                | • Labored respiration                                                                      | • Pulmonary thromboembolism                 |
|                           |                                          | • Unbearable fatigue                                                                       | • Modified Borg scale score of 5–8          |
|                           |                                          | • If the patient wants to stop                                                              |                                             |
|                           |                                          | • Complaint of pain                                                                        |                                             |
| Respiratory system        | • Respiratory rate                        | • 5 breaths/min or >40 breaths/min                                                         | • Except for evanescent increase            |
|                           | • SpO2                                    | • <88%                                                                                    |                                             |
|                           | • Breathing pattern                      | • Sudden breathing effort                                                                  | • Evaluation of airway obstruction by auscultion |
|                           | • Mechanical ventilator                  | • Unsynchronization                                                                       |                                             |
|                           |                                          | • Backing                                                                                 |                                             |
| Cardiovascular system     | • Heart rate                             | • Decreased heart rate and bradycardia                                                     | • Except for evanescent increase            |
|                           | • Electrocardiography                     | • 40/min or >130/min                                                                       |                                             |
|                           | • Blood pressure                         | • New arrhythmia                                                                          |                                             |
|                           |                                          | • Suspected myocardial ischemia                                                            |                                             |
|                           |                                          | • Systolic blood pressure > 180 mmHg                                                       |                                             |
|                           |                                          | • 20% decrease in systolic or diastolic blood pressure                                     |                                             |
|                           |                                          | • Average arterial pressure < 65 mmHg                                                      |                                             |
|                           |                                          | • Or >110 mmHg                                                                            |                                             |
| Device                    | • Artificial airway                       | • Risk of removal (or removal)                                                             |                                             |
|                           | • Nasogastric tube                        |                                                                                          |                                             |
|                           | • Central venous catheter                 |                                                                                          |                                             |
|                           | • Chest drain                             |                                                                                          |                                             |
|                           | • Wound drain                             |                                                                                          |                                             |
|                           | • Bladder catheter                        |                                                                                          |                                             |
| Other                     | • If the patient refuses                  | • Properties of drainage                                                                   |                                             |
|                           | • If the patient asks for cessation       | • Risk of wound separation                                                                |                                             |
|                           | • Suspected active bleeding               |                                                                                          |                                             |
|                           | • Surgical wound condition                |                                                                                          |                                             |

Cessation was determined depending on the patient’s condition or request to discontinue or resume.
safety of extending the walking distance and the life span, a rehabilitation program should also improve the daily living functions (standing up safely and standing with good balance and stability). Therefore, since 2018, Juntendo University Hospital has been using the Short Physical Performance Battery (SPPB) to assess the decline in motor function (e.g., slowness, decline in balance function) characteristic of older patients, especially those with cardiac disease. The SPPB consists of three components: 1) standing balance test, 2) walking speed test, and 3) chair–stand–up test. Each component is scored from 0 to 4 points according to motor ability to obtain a total score. The cardiac rehabilitation exercise program for older patients consists of four components: standing balance, walking speed, leg strength (power), and prolonged walking distance (endurance) (Table-5).

### Phase II cardiac rehabilitation

Aerobic exercise therapy aimed to improve physical exercise function is the core program of a comprehensive cardiac rehabilitation. Regular aerobic exercise is strongly recommended to improve exercise tolerance and symptoms in patients presenting with heart failure and to prevent readmission of those with reduced ejection fraction. Yokoyama et al. examined the effect of physical activity on coronary artery plaque volume in patients with acute coronary syndromes and found a reduced coronary artery plaque volume and lipid content in patients with acute coronary syndromes who actively participated in outpatient cardiac rehabilitation and showed high levels of physical activity.

On the other hand, the target patient population for cardiac rehabilitation has changed markedly with the super-aging of society, and physical therapy programs for older patients with heart disease must not be only aerobic exercise on bicycle ergometry. One of the main goals of physical therapy programs for older patients with heart disease must be to maintain and improve their ability to perform activities of daily living.

Our preliminary analysis suggested that approximately 20% of patients were discharged before they returned to their pre-hospitalization states due to a decline in physical function during their hospital stay. When patients who were already frail prior to hospitalization were included, approximately 35% of them were discharged with low physical function. Although there are high expectations for phase II cardiac rehabilitation as a preventive measure against worsening care needs after discharge from the hospital, cardiac rehabilitation in rehabilitation...
hospitals is rarely performed due to various medical insurance systemic restrictions. If there are restrictions on cardiac rehabilitation in rehabilitation hospitals, then there are high expectations for outpatient cardiac rehabilitation, but according to our survey, only 7% of patients underwent inpatient and outpatient cardiac rehabilitation in Japan.\(^24\)

The comprehensive cardiac rehabilitation program in phase II is strongly associated with long-term outcomes in patients with heart failure. In our most recent multicenter study with 3,277 patients, all-cause mortality and heart failure readmission rates were significantly lower in the group of patients who participated in outpatient cardiac rehabilitation at least once within three months of hospital discharge.\(^25\)

Despite advancements in medical technology, factors such as the aging of patients, mental anxiety after discharge, and physical distance from the hospital (coupled with the recent countermeasures against new coronavirus infections) still make outpatient visits difficult, and the implementation rate of outpatient cardiac rehabilitation in Japan is remarkably low, even internationally.

**Expectations for digital information and communication technology**

In recent years, with the development of digital information and communication technology, so-called telemedicine services, have been implemented in various fields and have become a worldwide trend. In the field of cardiac rehabilitation, experimental trials have begun, and we are conducting research on the practical application of “tele-rehabilitation” that incorporates the essence of rehabilitation medicine to re-acquire basic life functions and to prevent early severity of care needs.

**Conclusion**

The Juntendo University Hospital has been involved in cardiac rehabilitation for more than 20 years and continues to be the leading cardiac rehabilitation facility in Japan.

The present paper is a summary of the contents presented at the 350th Juntendo Medical Association Conference, on the early rehabilitation in Juntendo University Hospital, and the development of functional exercise therapy to overcome frailty in older patients and remote cardiac rehabilitation.

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**Conflict of interest statement**

The author declares no conflict interests.

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