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Original Article

Examination of factors related to the performance index of patients with cardiovascular disease in a convalescent rehabilitation hospital

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ABSTRACT
Fujii D, Morisawa T, Yamamoto S, Matsuo T, Nyuba K, Maehata M, Iwaki H, Iwata K, Saitoh M, Endo M, Takahashi T. Examination of factors related to the performance index of patients with cardiovascular disease in a convalescent rehabilitation hospital. Jpn J Compr Rehabil Sci 2024; 15: 63−70.
Objective: The purpose of this study was to identify the characteristics of patients with cardiovascular disease who received cardiac rehabilitation (CR) at a convalescent rehabilitation hospital (rehabilitation hospital) after treatment at an acute-care hospital and whose performance index was 40 or higher.
Methods: A total of 43 patients with cardiovascular disease were admitted to two rehabilitation hospitals. Based on the performance index, which is an indicator of the effectiveness of rehabilitation in rehabilitation hospitals, patients were classified into two groups: a "high-performance index group" (performance index of 40 or higher) and a "low-performance index group" (performance index of less than 40). We then compared the patient characteristics of the two groups.
Results: The high-performance group accounted for 62.8% of the total. Compared to patients in the low-performance group, high-performers were significantly younger at the time of admission to the rehabilitation hospital and had significantly higher physical function and exercise tolerance. The results of the effect size measurement showed that the effect size was 0.98 and 0.93 on the Short Physical Performance Battery (SPPB) at admission to the rehabilitation hospital and on the pre-illness Kihon checklist, respectively, which were related to the achievement of the performance index.
Conclusions: This study suggests that the SPPB at admission to a rehabilitation hospital and the pre-illness Kihon checklist are associated with obtaining a performance index of 40 or higher in patients with cardiovascular disease.
Key words: convalescent rehabilitation hospital; cardiovascular disease; performance index

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Introduction

The number of older patients with cardiovascular disease is rapidly increasing in Japan, which is a hyperaged society [1]. The average length of hospital stay for patients with cardiovascular disease is 14 to 16 days, and 16.2% of postoperative cardiac surgery patients require more than nine days to achieve independent ambulation, compared with the progression of cardiac rehabilitation (CR) as described in the guidelines of the Japanese Society of Cardiology [2−4]. In addition, older patients with cardiovascular disease are prone to declines in physical function and activities of daily living (ADL) during hospitalization due to the exacerbation of heart failure or surgical invasion. In addition, it has been shown that 10−20%

of patients are not fully recovered at the time of hospital discharge [5−7]. It has been pointed out that older and frail cardiac patients not only fail to achieve rehabilitation outcomes but also waste medical resources in acute-care hospitals and have difficulty participating in outpatient CR [8]. In the revision of the medical reimbursement system in 2022, “acute myocardial infarction, angina pectoris attack, other acute onset cardiovascular diseases, or postoperative conditions” were added to the list of conditions requiring convalescent rehabilitation [9].

Convalescent rehabilitation hospitals (rehabilitation hospitals) provide intensive and specialized rehabilitation and have been reported to be effective in restoring physical function, ADL, and exercise tolerance in patients with cardiovascular disease [10]. Many rehabilitation hospitals have implemented CR owing to the revision of medical fees and are expected to provide CR to older and frail patients with cardiac disease.

Rehabilitation hospitals use a hospitalization fee calculation system in which the performance index is evaluated, and a performance index exceeding 40 is a criterion for calculating the hospitalization fee 1 for rehabilitation wards [9]. The performance index is an indicator of the effectiveness of rehabilitation in a rehabilitation hospital, calculated from the difference in motor items of the Functional Independence Measure (FIM), an evaluation of ADL at the time of admission and discharge, and the number of days spent in a rehabilitation hospital. The higher the performance index, the greater the improvement in ADLs with a shorter hospital stay. It has been reported that the higher the performance index, the shorter the average length of hospital stay and the higher the return to home rate [11]. The performance index is an outcome of effective and efficient rehabilitation. Therefore, the performance index is an indicator of whether effective rehabilitation is being provided in rehabilitation hospitals, and obtaining a performance index of 40 or higher is very important for CR in rehabilitation hospitals. In addition, it has been reported that a decline in ADL increases rehospitalization and worsens prognosis in older patients with heart failure [12]. Thus, obtaining a performance index that indicates efficient improvement in ADL is very important for older patients with cardiovascular disease. However, a comparison of the performance index for each disease in rehabilitation hospitals shows that the index is 43.9 for cerebrovascular diseases and 39.8 for orthopedic diseases. In contrast, the index for disuse syndrome, which has been calculated for patients after treatment for cardiac diseases, is low at 26.0, making it difficult to manage hospital beds [13].

As mentioned above, the performance index reflects the ease of improving physical function and ADLs and whether efficient rehabilitation can be performed. It is therefore important to examine the factors involved in obtaining the target performance index for predicting the development of rehabilitation after admission to a rehabilitation hospital. However, although previous studies have reported on the factors involved in obtaining the target performance index for cerebrovascular disease [14], there have been no reports examining the factors involved in obtaining a performance index of 40 or higher for patients with cardiovascular disease in rehabilitation hospitals.

This study aimed to clarify the characteristics of patients admitted to a rehabilitation hospital for CR with cardiovascular disease as the primary illness to obtain a performance index of 40 or higher.

Methods

1. Study participants

This multicenter, prospective cohort study enrolled 45 consecutive patients with cardiovascular disease who were treated at an acute-care hospital but had residual physical and ADL disturbance due to serious complications and required continued CR at a rehabilitation hospital. Patients who were transferred from an acute-care hospital to two Japanese rehabilitation hospitals for CR between December 2020 and February 2022 were included in the study. The exclusion criteria were as follows: age <18 years, difficulty in walking due to conditions such as tetraplegia or hemiplegia due to cerebrovascular disease, spinal cord infarction, severe ischemic limb, lower limb defect, and failure to give consent to participate in the study. Patients who died during hospitalization or who could not continue hospitalization because of a wound infection or scheduled surgery were excluded from the study. Ultimately, 43 patients were included in the analysis. In addition to a rehabilitation program based on the guidelines of the Japanese Society of Cardiology [4], participants were provided with individual rehabilitation, such as ADL and balance training, for 120−180 minutes daily based on the condition of the patient. Occupational therapy and speech therapy were prescribed by the attending physician as needed. Because a performance index of 40 or higher is a criterion for calculating the hospitalization fee 1 for convalescent wards, the group with a performance index of 40 or higher was classified as the “high-performance group,” while that with a performance index of <40 was classified as the “low-performance group.”

2. Calculation of performance index

We calculated the performance index at discharge based on the number of days spent in the rehabilitation hospital and the FIM gain (FIM motor items at discharge minus FIM motor items at admission), according to the performance index calculation method of the Ministry of Health, Labour and Welfare

(MHLW) [15]. The FIM is often used to record patients' functional status in daily life and its changes. It consists of 13 motor items and 5 cognitive items, scored on a 7-point scale from 1 (fully assisted) to 7 (fully independent) [16]. FIM motor items at admission and discharge from the rehabilitation hospital were required to calculate the performance index, which skilled physical therapists and occupational therapists measured at the time of admission and discharge. Conventionally, a single value of the performance index is calculated for each ward, but in this study, the performance index was calculated for each individual, but is still referred to as the performance index for convenience.

Performance index = FIM gain (FIM motor items at discharge − FIM motor items at admission) / (number of days in hospital / maximum number of days for calculation of rehabilitation hospital admission fee)

3. Basic attributes and pre-illness life function

Age, sex, major diseases (heart failure, ischemic cardiovascular disease, postoperative cardiovascular surgery, and macrovascular disease), medical history (diabetes, hypertension, hyperlipidemia, Chronic kidney disease, chronic obstructive pulmonary disease, musculoskeletal disease, cerebrovascular disease, peripheral artery disease), and length of acute-care hospital stay were obtained from the patient's medical records. The physiotherapist responsible for the patient's pre-morbid life functions used the Kihon Checklist [17]. The Kihon Checklist is a questionnaire developed by the MHLW that consists of 25 questions on ADL, motor function, nutritional status, oral function, confinement, cognitive function, and depressed mood. For each question, one point was added if the patient was considered to have a problem. The higher the score, the more likely the patient was to have problems with life and physical and mental functions.

4. Laboratory data and physical function on admission to a rehabilitation hospital

Laboratory data at the time of hospitalization included brain natriuretic peptide (BNP), C-reactive protein (CRP), albumin (Alb), estimated glomerular filtration rate (eGFR), geriatric nutritional risk index (GNRI), and left ventricular ejection fraction (LVEF).

Cognitive function was assessed by an occupational therapist using the Japanese version of the Mini-Mental State Examination (MMSE) [18], which scores cognitive function on a scale of 0 to 30, with higher scores indicating better cognitive function.

The physiotherapist in charge measured all physical functions at the time of admission to the rehabilitation hospital. Physical function was assessed by measuring the Short Physical Performance Battery (SPPB), 6-minute walk distance (6 MWD), and percentage knee extension muscle strength. The SPPB is a reliable and valid assessment of physical function in older populations [19]. The total score was calculated using the method described by Guralnik et al. [20]. Balance ability, 4-m walking time, and five-times standing up time were each scored 4 points, for a total score of 12 points. The 6 MWD is an assessment of exercise tolerance, and the maximum distance that could be walked in 6 minutes was measured according to the standards of the American Thoracic Society [21]. The percentage of knee extension muscle strength was measured using a handheld dynamometer (Micro FET2, Hoggan Scientific). The knee joint was flexed at 90° in the sitting position, and two maximal knee extensions were performed. The percentage body weight was calculated by dividing the result by body weight (kg), and the maximum value was used.

5. Statistical analyses

Statistical analyses were performed to compare the two groups: the high-performance group with a performance index of 40 or higher at discharge, and the low-performance group with a performance index of less than 40. The Shapiro–Wilk test was used to compare basic attributes, laboratory data at admission to the rehabilitation hospital, physical function, and pre-morbid functional assessment between the two groups to confirm normality, and the Mann–Whitney U test and chi-square test was used for analysis. Cohen's d was also used to measure effect sizes for the items that showed significant differences in the Mann–Whitney U test: age, BMI, SPPB at admission to the rehabilitation hospital, 6 MWD, percentage knee extension muscle strength, and pre-illness Kihon Checklist. The statistical analysis software used was EZR version 1.61 (R Commander version 2.8−0), with a significance level of 5%.

6. Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki, and consent was obtained from all participants. The study was conducted after obtaining approval from the Ethics Committees of Hospital A (Approval No.: A025) and Hospital B (Approval No.: 13).

Results

1. Comparison of items and basic attributes involved in calculating the performance index

The high-performance group (performance index of 40 or higher at the time of discharge) accounted for 62.8% (n = 27), while the low-performance group (performance index of less than 40) accounted for 37.2% (n = 16) (Figure 1). A comparison of the items and basic attributes involved in calculating the performance index for the two groups is presented in Table 1. The high-performance group had significantly

Table 1. A comparison of the items and basic attributes involved in the calculation of the performance index for the two groups.

	Overall (n = 43)	High PI group (n = 27)	Low PI group (n = 16)	P-value
Performance index	64.7±53.8	87.4±55.9	26.3±13.3	<0.05
Length of stay in hospital, days	55.4±24.5	45.7±22.3	71.9±18.9	<0.05
FIM gain	29.9±13.3	35.5±10.3	20.6±12.6	<0.05
FIM at admission (motor item), points	47.9±16.6	50.3±13.0	44.1±20.4	0.14
FIM at discharge (motor item), points	77.9±18.9	85.8±7.2	64.6±24.7	<0.05
Age, y	77.0±12.9	74.4±10.2	80.8±16.2	<0.05
Sex, (male/ female), *n*	23/20	16/11	7/9	0.36
Major disease, % (*n*)				
Heart failure	14.0 (6)	3.7 (1)	31.3 (5)	<0.05
Ischemic cardiovascular disease	18.6 (8)	11.1 (3)	31.3 (5)	0.13
Postoperative Cardiovascular Surgery	30.2 (13)	37.0 (10)	18.8 (3)	0.31
Macrovascular disease	37.2 (16)	48.1 (13)	18.8 (3)	0.11
Medical history, % (*n*)				
Diabetes	32.6 (14)	22.2 (6)	50.0 (8)	0.09
Hypertension	72.1 (31)	92.6 (25)	37.5 (6)	<0.05
Hyperlipidemia	44.2 (19)	51.9 (14)	31.3 (5)	0.22
Chronic kidney disease	16.3 (7)	14.8 (4)	18.8 (3)	1
COPD	11.6 (5)	11.1 (3)	12.5 (2)	1
Musculoskeletal disease	44.2 (19)	33.3 (9)	62.5 (10)	0.11
Cerebrovascular disease	16.3 (7)	14.8 (4)	18.8 (3)	1
Peripheral artery disease	11.6 (5)	11.1 (3)	12.5 (2)	1
Length of stay in acute care hospitals, days	42.9±29.9	41.3±31.1	45.6±28.4	0.55

[a] Mean ± SD [b]PI, performance index; FIM, functional independence measure; COPD, chronic obstructive pulmonary disease

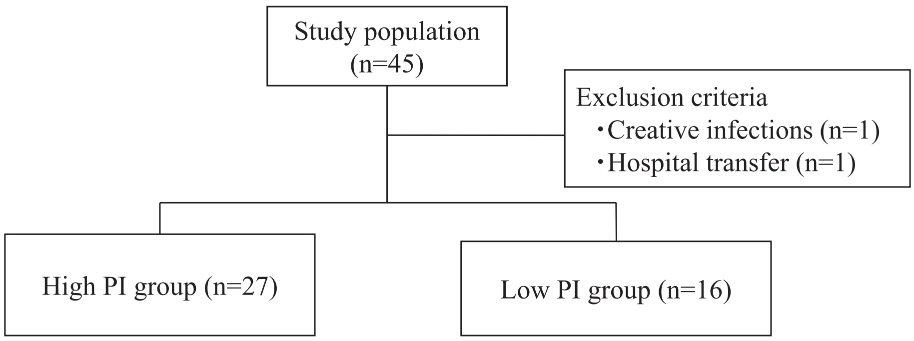

Figure 1. Flowchart of analysis subjects.
[a]PI, performance index

lower values for days of rehabilitation, age, and participants with heart failure as the primary disease than the low-performance group ($p < 0.05$). The high-performance group had a significantly higher FIM gain and hypertension than the low-performance group ($p < 0.05$).

2. Comparison of laboratory data, physical function, and pre-illness functional assessment upon admission to a rehabilitation hospital

The results of the laboratory data, physical function, and pre-illness functional assessment at the time of admission to the rehabilitation hospital are shown in Table 2. The high-performance group had significantly higher BMI, SPPB, 6 MWD, and percentage knee extension muscle strength than the low-performance group ($p < 0.05$). The pre-illness Kihon Checklist score was significantly lower in the high-performance group ($p < 0.05$).

3. Measurement of effect size

As a result of measuring the effect size using Cohen's d for the items that showed significant differences in the Mann–Whitney U test, the effect size was 0.98 and 0.93 for the SPPB at admission to the rehabilitation hospital and the pre-illness Kihon

Table 2. Comparison of laboratory data, physical function, and pre-illness functional assessment at admission to a rehabilitation hospital.

	Overall (*n* = 43)	High PI group (*n* = 27)	Low PI group (*n* = 16)	*P*-value
LVEF at admission, %	52.1±15.4	53.0±16.7	50.6±13.4	0.42
BMI at admission, kg/m^2	21.4±4.4	22.2±4.4	20.0±4.1	<0.05
GNRI at admission, points	90.1±12.6	92.5±9.2	86.0±16.3	0.38
Alb at admission, g/dL	3.4±0.4	3.4±0.4	3.4±0.4	0.53
eGFR at admission, mL/min/1.73m^2	62.6±26.6	61.3±27.3	63.3±26.2	0.52
BNP at admission, pg/mL	267.2±245.5	254.0±254.3	289.5±236.3	0.61
CRP at admission, mg/L	1.8±2.6	1.5±2.4	1.9±0.5	0.06
MMSE at admission, points	24.8±4.2	25.2±4.6	24.1±3.3	0.19
SPPB at admission, points	7.1±4.3	8.6±3.9	4.8±3.8	<0.05
6MWD at admission, m	179.8±145.5	219.3±148.5	113.1±116.1	<0.05
Percentage knee extension muscle strength at admission, %	27.6±14.5	31.0±16.0	21.6±9.0	<0.05
Pre-illness KCL, points	9.3±5.8	7.4±5.3	12.4±5.5	<0.05

a)Mean ± SD

b)PI, performance index; LVEF, left ventricle ejection fraction; BMI, body mass index; GNRI, geriatric nutritional risk index; Alb, albumin; eGFR, estimated glomerular filtration rate; BNP, brain natriuretic peptide; CRP, c-reactive protein; MMSE, mini mental state examination; SPPB, short physical performance battery; 6MWD, 6-min walking distance; KCL, Kihon checklist.

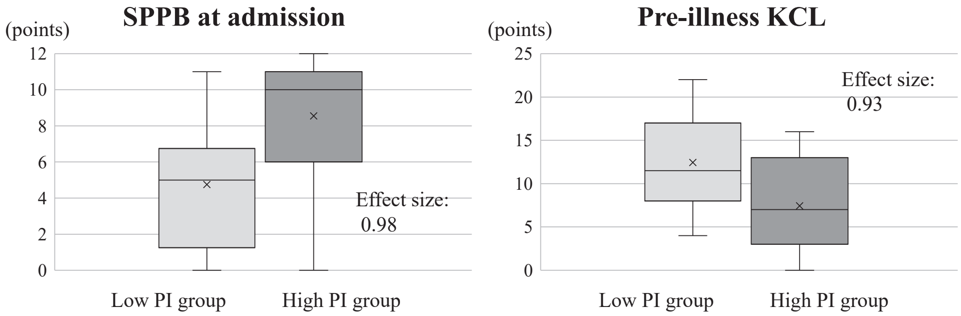

Figure 2. Comparison of the effect size of both groups.
a) PI, performance index; SPPB, short physical performance battery; KCL, Kihon checklist
Box, 25%tile to 75%tile; horizontal bar, median; ×, mean.

checklist, respectively, and was found to be associated with obtaining the target performance index (Figure 2).

The effect sizes of 0.77 for 6 MWD, 0.68 for percentage knee extension muscle strength, and 0.51 for BMI were moderate; 0.48 for age was small and not significantly related to obtaining the target performance index (effect size: large 0.8, medium 0.5, small 0.2) [22] (Figure 3).

Discussion

The main findings of this study were as follows: the proportion of consecutive postoperative patients transferred from an acute-care hospital to a rehabilitation hospital for CR purposes in the high-performance group was 62.8%. The average age of the high-performance group was younger than that of the low-performance group, and their physical function (SPPB and knee extension muscle strength) and exercise tolerance at the time of admission to the rehabilitation hospital were maintained, indicating that they had a high pre-symptomatic life function. Among the items for which significant differences were found, those with high effect sizes and strong relation to the acquisition of the target performance index were the SPPB at the time of admission to the rehabilitation hospital and the pre-illness Kihon Checklist.

Of the items that may have been particularly relevant to obtaining the target performance index, the SPPB is essential because it is a battery test that can comprehensively assess lower limb functions, such as lower limb muscle strength and balance in the older population, and is associated with ADL disturbance and decline in quality of life (QOL) [23, 24]. The SPPB is also considered to be highly useful for the assessment of physical function in older cardiac

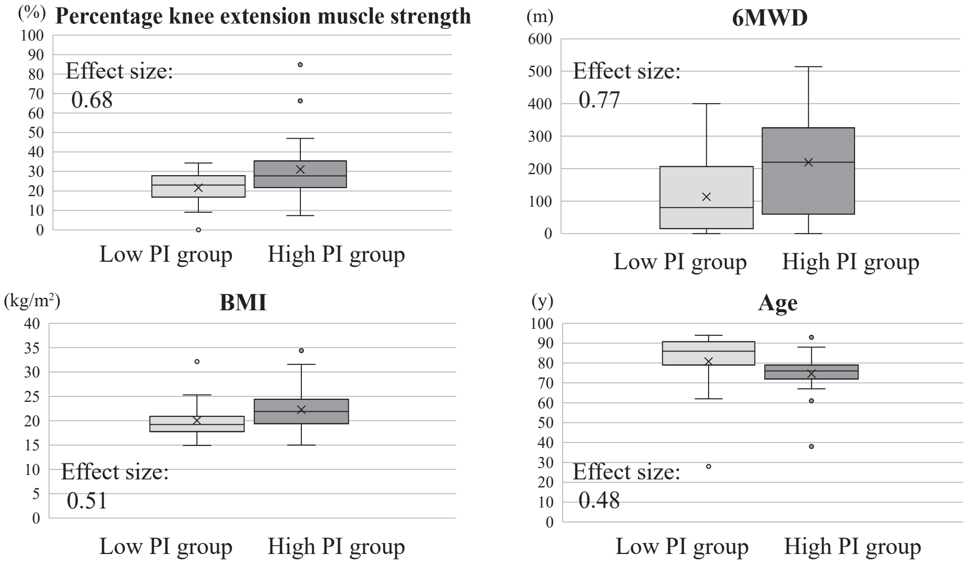

Figure 3. Comparison of the effect size of both groups.
a) PI, performance index; 6MWD, 6-min walking distance; BMI, body mass index Box, 25%tile to 75%tile; horizontal bar, median; ×, mean.

patients with a predicted decline in lower limb function [4]. This suggests that the low-performance group had lower limb function at the time of admission to the rehabilitation hospital, which may have caused a decline in ADL, activity levels, and QOL. Therefore, it is possible that patients require a longer period to improve their physical functions necessary for acquiring ADL at a rehabilitation hospital, suggesting that it takes time to acquire ADL and recover physical functions. In addition, previous studies have shown that a preoperative decline in physical function is associated with lower ADL at the time of discharge from acute-care hospitals [25], and the same was true for rehabilitation hospitals, where a decline in physical function at the time of admission was associated with lower ADL.

In addition, the pre-illness Kihon Checklist of the low-performance group exceeded the frail cutoff value of 8 points [26], suggesting that they may have had lower life functions predating their illness. It has been reported that the time to achieve ambulatory independence in the ward is delayed when the patient's pre-illness life function is low and they initially need some assistance with ADLs. ADL disturbance before admission has been described as a contributing factor to inadequate recovery of physical function and ADL during hospitalization [3, 27, 28]. It has also been stated that it is more realistic to aim for the pre-illness ADLs, rather than for independent movement in subjects with low life function who required assistance with ADL before their illness [29]. It is expected that the low-performance group would require assistance with ADL before their illness, and would have long-standing disuse before the onset of their illness. It is possible that the low-performance group needed a sufficient period of general conditioning and base-up prior to the interventions aimed at gaining ADL. Therefore, it is possible that ADL could not be performed smoothly, resulting in a prolonged hospitalization period. In addition, it is possible that the low-performance group, whose range of living and daily functions were considered to have deteriorated even before the disease, had low FIM scores and that it was difficult to recognize numerical changes during rehabilitation aimed at acquiring the pre-illness ADL.

The 6 MWD, percentage knee extension muscle strength, and BMI were moderate effect sizes. The 6 MWD is an assessment of exercise tolerance, and its prognostic value for patients with heart failure is similar to that of Peak$\dot{V}O_2$ [30]. In general, patients with cardiovascular disease have subjective symptoms during exercise, such as dyspnea and fatigue during exertion, which is associated with reduced cardiac function and exercise tolerance. They can easily stress physical and mental functions, possibly leading to a risk of exacerbation of heart failure and reduced activity. The subjects in the high-performance group had relatively high exercise tolerance from the time of admission to the rehabilitation hospital, which may have made it easier to apply the exercise load and promptly develop rehabilitation skills compared to the low-performance group. It has been reported that ten days of bed rest in healthy older patients decreases exercise tolerance and muscle strength by 12−13% and that lower nutritional status contributes to less effective rehabilitation interventions [31, 32], which is consistent with the characteristics of the low-performance group with low percentage knee extension muscle strength and BMI. Although this study did not find a significant difference in the number of days spent in acute-care hospitals, the characteristics of the low-performance group suggest that they were unable to engage in active exercise to prevent or improve disuse, such as prolonged bed rest due to difficulty in postoperative control at acute-care hospitals, and that they suffered a severe decline in ADL upon admission to rehabilitation hospitals, and that it took time to improve their ADL.

In Japan, as the population of cardiac patients ages, the number of patients with characteristics of the low-performance group is expected to increase. The guidelines of the Japanese Cardiovascular Society clearly state that CR in rehabilitation hospitals should include a comprehensive disease management program, including mental evaluation, return-to-work guidance, and psychological support, in addition to exercise therapy, smoking cessation guidance, diet therapy, and appropriate treatment of coronary risk factors [4]. In other words, rehabilitation hospitals are required to provide comprehensive interventions that not only improve physical functions, but also provide lifestyle guidance, environmental adjustments, and guidance to patients and their families in consideration of their subsequent return to home and society.

In this study, we investigated items related to obtaining a performance index of 40 or higher in patients with cardiovascular disease admitted to a rehabilitation hospital. In Japan, where there are many older patients, and the number of patients with low-performance group characteristics is likely to increase in the future, it is essential to evaluate the items involved in obtaining the target performance index to identify patients who need time to improve their ADL during the recovery period when comprehensive intervention is required, and patients who have difficulty improving their ADL and need nursing care services and environmental adjustments. This may be a predictive factor for providing necessary rehabilitation to those who need it, such as providing a rehabilitation period according to their needs, adjusting services, and supporting discharge from the hospital. These results suggest that smooth CR in rehabilitation hospitals may be necessary in the future.

This study had several limitations. Although this was a two-center study, the sample size was small and insufficient. It was also difficult to identify events in acute-care hospitals. Notably, patients admitted to rehabilitation hospitals have varied conditions, and their rehabilitation often requires individualization. However, it is difficult to understand the interventions implemented because of their variations.

Conclusion

In conclusion, the SPPB at admission to a rehabilitation hospital and the pre-illness Kihon Checklist were associated with attaining a performance index of 40 or higher in patients with cardiovascular disease.

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