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ORIGINAL REPORT

MALNUTRITION IS ASSOCIATED WITH POOR REHABILITATION OUTCOME IN ELDERLY INPATIENTS WITH HOSPITAL-ASSOCIATED DECONDITIONING: A PROSPECTIVE COHORT STUDY

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Objective: **To investigate the association between nutritional status and rehabilitation outcome in elderly inpatients with hospital-associated deconditioning.**
Design: **A prospective cohort study.**
Subjects/patients: **One hundred sixty-nine consecutive elderly inpatients diagnosed with hospital-associated deconditioning.**
Methods: **Nutritional status at referral was assessed by the Mini Nutritional Assessment Short Form at the University Medical Center. Body mass index, haemoglobin, albumin, total lymphocyte count, C-reactive protein, cause of malnutrition, and feeding route were also investigated. Primary outcome was Barthel Index score at discharge.**
Results: **A total of 148 patients (87.6%) were malnourished, and 21 were at risk for malnutrition. There were no patients with normal nutritional status. Malnourished patients had a lower Barthel Index score at discharge than those at risk for malnutrition. Chronic disease-related malnutrition, oral intake, and parenteral nutrition were associated with the Barthel Index score at discharge. There were significant correlations between the Barthel Index score at discharge and nutritional score, albumin, and total lymphocyte count. In multiple regression analysis, Mini Nutritional Assessment Short Form, albumin, and chronic disease-related malnutrition were significantly associated with the Barthel Index score at discharge.**
Conclusion: **Most elderly inpatients with hospital-associated deconditioning are malnourished. Nutritional status, albumin, and chronic disease-related malnutrition are associated with poor rehabilitation outcome in hospital-associated deconditioning.**

Key words: deconditioning; asthenia; malnutrition; rehabilitation; sarcopaenia.

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INTRODUCTION

Hospital-associated deconditioning is characterized by the functional decline that occurs during acute hospitalization due to illness injury, and unrelated to a specific neurological and/or orthopaedic insult (1). The concepts of hospital-associated deconditioning, disuse syndrome, hospitalization-associated disability, and debility have been proposed to define the consequences of physical inactivity. Okawa et al. (2) conceptualized the disuse syndrome model of elderly people as a gradual decline or stepwise downhill trend in functioning. Using these criteria, they classified 226 of 542 elderly patients (41.4%) with functional decline as having disuse syndrome. Hospitalization-associated disability occurs in approximately one-third of patients older than 70 years of age and may be triggered even when the illness that necessitated the hospitalization is successfully treated (3). On the basis of these figures, hospital-associated deconditioning represents a relatively important condition in geriatric rehabilitation medicine.

In a review article, the prevalence of malnourished elderly patients in the rehabilitation setting was 50.5%, with 41.2% at risk for malnutrition; only 8.5% were classified as having a normal nutritional status (4). In Dutch rehabilitation centres, 28% of patients were severely undernourished and 10% were moderately undernourished (5). Because malnutrition is so common, nutritional assessment is crucial in geriatric rehabilitation. Causes of malnutrition are classified as follows: starvation-related malnutrition, when chronic starvation is present without inflammation; chronic disease-related malnutrition, when mild to moderate inflammation is chronic; and acute disease or injury-related malnutrition, when inflammation is acute and of a severe degree (6). Malnourished patients may have more than one cause for their nutritional status. In a study of 187 elderly ambulatory rehabilitation patients, 30 had starvation-related malnutrition, 37 were cachectic, 75 had sarcopaenia, and 20 were identified as having all 3 conditions (7).

Rehabilitation outcome has been shown to be poor in malnourished patients with stroke (8), chronic heart failure (9), chronic obstructive pulmonary disease (9), and a variety of other diseases. It has therefore been suggested the relationship between nutritional supplementation and rehabilitation from hospital-associated deconditioning is an important area of research (1).

In an acute rehabilitation setting, obese patients with deconditioning show greater improvement in activities of daily living (ADL), measured by functional independence measure (FIM) scores, compared with patients who either have a body

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mass index (BMI) in the normal range, or who are underweight (BMI < 18.5) and deconditioned. This latter group shows the smallest increase in FIM motor scores with rehabilitation (10). In elderly patients with deconditioning, admission Norton scale scores correlated with discharge walking FIM scores ($r = 0.32$; $p = 0.003$), discharge transfer FIM scores ($r = 0.30$; $p = 0.005$), and length of rehabilitation ($r = –0.37$; $p < 0.0001$), following adjustment for age, albumin serum levels, and mini-mental state examination scores (11). In our previous retrospective cohort study (12), 91% of patients with hospital-associated deconditioning were defined as being malnourished. The rehabilitation outcome was better in patients with normal nutrition, compared with malnourished patients. This study, however, was hampered by the lack of a validated nutritional assessment method.

The aim of the current study was therefore to investigate the association between malnutrition, evaluated by a validated nutritional assessment method, and poor rehabilitation outcome in elderly inpatients with hospital-associated deconditioning.

MATERIAL AND METHODS

Study design and subjects

A prospective cohort study was conducted of consecutive patients, aged 65 years and above, admitted to the University Medical Center (tertiary-care acute general hospital, 15.0 day mean length of stay, 715 beds) between April 2010 and March 2011. All patients were referred to the department of rehabilitation medicine by attending physicians. Patients were required to be diagnosed with hospital-associated deconditioning by a staff physiatrist. All patients were prescribed physical therapy 5 times a week at the bedside or gymnasium, including range of motion exercises, resistance training, physical restoration, movement exercises, and ambulation exercises in the University Medical Center. Each session of physical therapy was 1 or 2 units (1 rehabilitation unit equated to 20 min of therapy). A few patients were also prescribed occupational therapy including functional occupational therapy, ADL exercise, cognitive training, and speech therapy including dysphagia rehabilitation.

Physicians diagnosed hospital-associated deconditioning by meeting all of the following criteria: (*i*) a period of inactivity or bed restriction after acute hospitalization; (*ii*) a new disability to complete one of the basic ADLs needed to live independently without assistance: bathing, dressing, rising from bed or a chair, using the toilet, eating, or walking across a room during acute hospitalization (3); (*iii*) a new disability is unrelated to a specific neurological or orthopaedic insult, or both (1, 11); (*iv*) Barthel Index (13) score is 85 points or under.

According to the guidelines for hospital-associated deconditioning determined by the Japanese Ministry of Health, Labour and Welfare, only patients whose Barthel Index score is 85 points or less can be diagnosed with hospital-associated deconditioning. The inclusion criteria for this study consisted of a diagnosis of hospital-associated deconditioning by a staff physiatrist, and age older than 65 years. The exclusion criterion was a score of greater than 85 Barthel Index points at the first physical therapy appointment, as evaluated by physical therapists.

The study was approved by the ethics committee of the university hospital, with informed consent being obtained from all participants prior to enrolment in the study.

Measurements

Rehabilitation outcome was assessed by the Barthel Index at discharge. Nutritional status at referral was assessed by the Mini Nutritional Assessment Short Form (MNA-SF) (14–16). The MNA-SF comprises 6 questions that ask about reduction in food intake over the past 3 months, weight loss during the last 3 months, mobility, psychological stress or acute disease in the past 3 months, neuropsychological problems, and BMI. BMI, haemoglobin (Hb), serum albumin (Alb), total lymphocyte count (TLC), C-reactive protein (CRP), and feeding route (oral intake, enteral nutrition, or parenteral nutrition) were also assessed.

Starvation-related malnutrition was defined as an energy intake inadequate to meet basal energy expenditure. Total energy intake was calculated by adding oral intake, enteral nutrition, and parenteral nutrition on the day of referral. Basal energy expenditure was calculated by the Harris-Benedict equation (17). Chronic disease-related malnutrition was assessed by the European Society for Clinical Nutrition and Metabolism consensus diagnostic criteria for pre-cachexia (18). According to this consensus, all of the following must be present to diagnose pre-cachexia: (*i*) underlying chronic disease; (*ii*) unintentional weight loss of less than 5% of usual body weight during the last 6 months; (*iii*) chronic or recurrent systemic inflammatory response; (*iv*) anorexia or anorexia-related symptoms (18). Acute disease or injury-related malnutrition was diagnosed by the presence of acute disease or injury, at or following admission.

To minimize information bias, nutritional status at referral was evaluated by physiatrists. Barthel Index at discharge was evaluated by physical therapists blinded to the patient's nutritional status.

Sample size calculation

A study size analysis was performed using Power and Sample Size Calculation software version 3.0 (http://biostat.mc.vanderbilt.edu/twiki/bin/view/Main/PowerSampleSize). In our previous study, the mean Barthel Index score at referral was 32.8 (standard deviation (SD) 30.5); 91% of patients were malnourished and 9% were not malnourished (12). The minimal significant clinical difference in Barthel Index scores is defined as 10 points, meaning the difference between independent and dependent status for one item of ADL. In order to detect a mean difference of 10 Barthel Index points (with a SD of 30) between groups when the malnutrition to normal nutrition ratio is 10:1, 50 malnutrition patients and 5 normal nutrition patients would be needed for a power (1–β) of 0.9 and an α of 0.05. Because we were able to recruit 223 patients over 13 months in our previous cohort study, the current study was designed to encompass 1 year.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 19 software. Data with a normal distribution were described by the mean (SD). If not normally distributed, data were described by the median and range (25%, 75%). Associations were examined between the MNA-SF score, BMI, Hb, Alb, TLC, CRP, feeding route, cause of malnutrition, and Barthel Index score at discharge. Because Barthel Index scores were not normally distributed, the Mann-Whitney *U* test, Spearman's rank correlation coefficient, and multi-regression analysis (stepwise procedure) were used for statistical analysis. Difference between aetiology of hospital-associated deconditioning was analysed by χ^2 test, analysis of variance, Kruskal-Wallis test, and Bonferroni's multiple comparison test. *p*-values < 0.05 were considered statistically significant.

RESULTS

During the research period, 176 patients were diagnosed with hospital-associated deconditioning. Seven patients whose Barthel Index score at the first physical therapy appointment was greater than 85 points were excluded from the study. The remaining 169 patients, 97 men and 72 women, with a mean age of 78.6 years (Table I) were included in the study. Common

Table I. *Demographics of participants (*n = *169)*

	Statistical analysis
Age, years, mean (SD)	79 (7)
Gender: men/women, *n* (%)	97 (57)/72 (43)
Diagnosis of causative disease at admission, *n* (%)	
Cardiovascular diseases	63 (37)
Heart failure	25
Ruptured aortic aneurysm	10
Elective aortic aneurysm surgery	8
Acute myocardial infarction	5
Elective coronary artery bypass graft surgery	4
Aortic dissection	4
Other cardiovascular diseases	7
Gastroenterological diseases	39 (23)
Oesophageal cancer	10
Colon cancer	7
Hepatocellular carcinoma	4
Cholangiocarcinoma	4
Ileus	4
Gastric cancer	3
Other gastroenterological diseases	7
Kidney and urological diseases	35 (21)
Chronic renal failure	20
Prostate cancer	7
Acute renal failure	3
Other kidney and urological diseases	5
Psychiatric diseases	8 (5)
Depression	7
Delirium	1
Haematological diseases	7 (4)
Malignant lymphoma	3
Acute myeloid leukaemia	2
Multiple myeloma	2
Respiratory diseases	6 (4)
Pneumonia	3
Interstitial pneumonia	2
Lung cancer	1
Other diseases	11 (7)
Duration between admission and referral, median (25%, 75%)	13 (7, 21)
Duration between referral and discharge, median (25%, 75%)	19 (11, 39.5)
Rehabilitation setting: bedside/gymnasium, *n* (%)	119 (70)/50 (30)
Barthel Index at referral, median (25%, 75%)	37 (5, 54)
Barthel Index at discharge, median (25%, 75%)	55 (22.5, 75)

SD: standard deviation.

Table II. *Nutritional status of participants at referral*

	Statistical analysis
MNA-SF, median (25%, 75%)	5 (3.5, 6)
Malnutrition, *n* (%)	148 (88)
At risk of malnutrition, *n* (%)	21 (12)
Normal nutritional status, *n* (%)	0 (0)
Cause of malnutrition, *n* (%)	
Starvation-related malnutrition	75 (44)
Chronic disease-related malnutrition	51 (30)
Acute disease or injury-related malnutrition	141 (83)
Feeding route, *n* (%)	
Oral intake	112 (66)
Enteral nutrition	33 (19)
Parenteral nutrition	111 (65)
Body mass index, kg/m^2, mean (SD)	20.6 (3.6)
Serum albumin, g/dl, mean (SD)	2.6 (0.6)
Haemoglobin, g/dl, mean (SD)	9.7 (1.7)
Total lymphocyte count, cells/mm^3, mean (SD)	947 (648)
C-reactive protein, mg/dl, median (25%, 75%)	2.66 (0.91, 6.07)

MNA-SF: Mini Nutritional Assessment Short Form.
Cause of malnutrition: 89 patients had more than 2 causes.
Feeding route: 86 patients had more than 2 routes.

aetiologies of hospital-associated deconditioning were cardiovascular diseases, gastroenterological diseases, and kidney and urological diseases. The median period between admission and referral to department of rehabilitation medicine was 13 days. Bedside physical therapy was prescribed for 119 patients, and 50 went to the gymnasium for therapy. The median Barthel Index score at discharge was 55 points.

The nutritional status of participants is summarized in Table II. MNA-SF revealed that 148 patients (87.6%) were malnourished, 21 patients were at risk for malnutrition, and no patients had a normal nutritional status.

Acute disease or injury-related malnutrition was the most frequent cause of malnutrition (141 patients, 83.4%). Two or more causes of malnutrition were implicated in 89 patients: 43 patients with starvation and acute disease or injury; 16 patients with chronic disease and acute disease or injury; 9 patients with starvation and chronic disease; and 21 patients with all causes.

Oral intake (112 patients, 66.3%) and parenteral nutrition (111 patients, 65.7%) were the most common feeding routes. Two or more routes were noted in 86 patients: 61 patients had both oral intake and parenteral nutrition; 2 patients had both oral intake and enteral nutrition; 19 patients had both enteral nutrition and parenteral nutrition; and 4 patients used all feeding routes.

The association between nutritional status, gender, age, and ADL is reported in Tables III–IV. Malnourished patients

Table III. *Nutritional status, gender and ADL: Mann-Whitney* U*-test*

	Yes Median (25%, 75%)	No Median (25%, 75%)	*p*-value
MNA-SF: malnutrition	52 (15, 75)	63 (55, 89)	0.017
Starvation-related malnutrition	54 (27, 75)	56 (20, 75)	0.925
Chronic disease-related malnutrition	49 (10, 63)	59 (27, 80)	0.003
Acute disease or injury-related malnutrition	55 (40, 75)	55.5 (16, 75)	0.318
Oral intake	59 (37, 78)	37 (0, 71)	0.002
Enteral nutrition	39.5 (0, 72)	57 (33, 70)	0.073
Parenteral nutrition	50 (8, 75)	64.5 (45, 77.5)	0.010
Gender: men	52 (0, 53)	57 (16, 55)	0.160

ADL: activities of daily living, Barthel Index score at discharge; MNA-SF: Mini Nutritional Assessment Short Form.

Table IV. *Nutritional status, age and ADL: Spearman's rank correlation*

	MNA-SF	BMI	Hb	Alb	TLC	CRP	Age
ADL	0.213*	0.147	0.113	0.321*	0.171*	–0.112	–0.111
MNA-SF		0.691*	–0.002	0.133	0.131	–0.175*	0.040
BMI			0.097	0.017	0.116	0.034	0.039
Hb				0.259*	0.172*	–0.156*	0.064
Alb					0.336*	–0.484*	0.077
TLC						–0.215*	0.106
CRP							–0.078

*$p < 0.05$.

ADL: activities of daily living, Barthel Index score at discharge; MNA-SF: Mini Nutritional Assessment Short Form; BMI: body mass index; Hb: haemoglobin; Alb: serum albumin; TLC: total lymphocyte count; CRP: C-reactive protein.

scored lower on the Barthel Index score at discharge than patients at risk for malnutrition. Chronic disease-related malnutrition was associated with a lower Barthel Index score at discharge. Patients with oral intake, and without parenteral nutrition, had significantly higher Barthel Index scores at discharge. There were significant correlations found between MNA-SF scores, Alb level, TLC, and Barthel Index score at discharge.

In multiple regression analysis, Spearman's rank correlation coefficients and phi (ϕ) coefficients were analysed. Multiple regression analysis then included age, gender, MNA-SF score, Alb level, TLC, chronic disease-related malnutrition, oral intake, and parenteral nutrition. Alb level, MNA-SF score, and chronic disease-related malnutrition were independently associated with the Barthel Index score at discharge (Barthel Index score = 17.51 × Alb + 2.78 × MNA-SF score + 11.28 × chronic disease-related malnutrition (yes: 1, no: 2) – 29.69, $R^2 = 0.19$, $p < 0.001$).

The Barthel Index score at referral was higher in kidney and urological diseases compared with cardiovascular and gastroenterological diseases (Table V). In contrast, the score at discharge was not statistically different between the various diseases. The median MNA-SF score was better in kidney and urological diseases compared with cardiovascular and gastroenterological diseases and psychiatric diseases. Acute disease or injury-related malnutrition was less common in patients with psychiatric diseases. Oral intake was the most common feeding route in kidney and urological diseases. On the other hand, parenteral nutrition was the most frequent feeding route in cardiovascular and gastroenterological diseases. Alb levels were significantly higher in psychiatric and kidney and urological diseases compared with gastroenterological and haematological diseases. Hb level in patients with respiratory diseases was higher than in patients with kidney and urological disease and haematological diseases. Median CRP value was significantly higher in cardiovascular diseases compared with kidney and urological diseases.

Table V. *Difference between aetiology of hospital-associated deconditioning*

	Cardiovascular	Gastroenterological	Kidney and urological	Psychiatric	Haematological	Respiratory	Other	*p*-value
Age, years, mean (SD)	81 (7)	77 (5)	79 (6)	73 (7)	73 (4)	79 (6)	79 (10)	0.010
Gender: men/women, *n*	35/28	29/10	19/16	2/6	4/3	3/3	5/6	0.172
Barthel Index at referral, median (25%, 75%)	30 (0, 52)*	32 (0, 52)	52 (27, 67)*	50 (5, 54)	34 (12.5, 41)	32.5 (13.5, 66)	39 (10, 62)	0.025
Barthel Index at discharge, median (25%, 75%)	54 (15, 75)	42 (0, 70)	59 (33, 84)	75 (57, 84)	52 (50, 79)	9 (0, 67)	47 (10, 72)	0.154
MNA-SF, median (25%, 75%)	5 (3, 6)*	4 (3, 6)*	6 (5, 8)*	2.5 (1, 4)*	5 (3, 7)	5 (3, 7)	5 (4, 7)	0.001
Malnutrition, *n* (%)	58 (92)	36 (92)	25 (71)	8 (100)	6 (86)	6 (100)	9 (82)	0.048
At risk of malnutrition, *n* (%)	5 (8)	3 (8)	10 (29)	0 (0)	1 (14)	0 (0)	2 (18)	
Cause of malnutrition, *n* (%)								
Starvation-related malnutrition	34 (54)	18 (46)	12 (34)	3 (38)	3 (43)	2 (33)	3 (27)	0.469
Chronic disease-related malnutrition	14 (22)	16 (41)	10 (29)	0 (0)	4 (57)	3 (50)	4 (36)	0.079
Acute disease or injury-related malnutrition	55 (87)	35 (90)	29 (83)	3 (38)	5 (71)	6 (100)	8 (73)	0.010
Feeding route, *n* (%)								
Oral intake	41 (65)	18 (46)	30 (86)	6 (75)	6 (86)	4 (67)	7 (64)	0.024
Enteral nutrition	13 (21)	11 (28)	1 (3)	5 (63)	1 (14)	1 (17)	4 (36)	0.006
Parenteral nutrition	51 (81)	30 (77)	17 (49)	3 (38)	5 (71)	2 (33)	3 (27)	<0.001
Body mass index, kg/m^2, mean (SD)	20.9 (3.7)	20.3 (3.7)	21.0 (3.7)	19.7 (2.6)	21.5 (2.7)	20.5 (4.9)	19.9 (3.4)	0.889
Serum albumin, g/dl, mean (SD)	2.6 (0.6)	2.4 (0.5)*	2.8 (0.7)*	3.3 (0.5)*	2.4 (0.5)*	2.7 (0.3)	2.7 (0.6)	0.001
Haemoglobin, g/dl, mean (SD)	9.9 (1.8)	9.4 (1.2)	8.9 (1.5)*	10.6 (1.2)	8.6 (0.9)*	11.4 (2.3)*	10.5 (1.9)	<0.001
Total lymphocyte count, cells/mm^3, median (25%, 75%)	837 (566, 1285)	595 (425, 980)	968 (592, 1454)	955 (641, 1109)	499 (391, 962)	1305 (985, 1675)	584 (212, 1116)	0.004
C-reactive protein, mg/dl, median (25%, 75%)	3.7 (1.4, 8.5)*	4.8 (1.5, 8.0)	1.9 (0.3, 3.3)*	0.7 (0.3, 6.7)	5.8 (0.8, 7.7)	1.0 (0.2, 2.2)	1.6 (0.7, 3.6)	0.001

*$p < 0.05$ in Bonferroni's multiple comparison test. MNA-SF: Mini Nutritional Assessment Short Form; SD: standard deviation.

DISCUSSION

Of the elderly inpatients with hospital-associated deconditioning in this study, 87.6% were malnourished, and none had a normal nutritional status as defined by MNA-SF. Alb level, MNA-SF score, and chronic disease-related malnutrition were independently associated with the Barthel Index score for ADL. These results are similar to our previous retrospective cohort study (12), which showed that 91% of inpatients with hospital-associated deconditioning were malnourished. This study raises the hypothesis that hospital-associated deconditioning is a result not only of inactivity, but also of malnutrition.

The MNA-SF is associated with poor clinical outcomes and is able to predict functional decline in the acute medical ward. When the MNA-SF is integrated with Alb level, an effective instrument to detect older inpatients at higher risk of undergoing functional decline is obtained (19). Both MNA-SF and Alb level can be associated with rehabilitation outcome in elderly inpatients.

Semi-starvation, chronic disease-related malnutrition, reduced physical activity, and ageing are external factors which may alter peripheral skeletal muscle (20). In our study, 44.4% of patients had starvation-related malnutrition, 30.2% of patients had chronic disease-related malnutrition, all patients had reduced physical activity, and all were aged 65 years and above. Skeletal muscle mass, muscle strength, and ADL are reduced by all of these conditions, and these conditions can lead to sarcopaenia. Sarcopaenia is a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength, with a risk of adverse outcomes such as physical disability, poor quality of life, and death (21). Primary sarcopaenia is considered to be age-related when no other cause is evident. Secondary sarcopaenia should be considered when one or more other causes are evident; examples include activity-related sarcopaenia, disease-related sarcopaenia, and nutrition-related sarcopaenia.

Disuse muscle atrophy in hospital-associated deconditioning is considered to be the same as activity-related sarcopaenia. Starvation-related malnutrition is similar to nutrition-related sarcopaenia. Acute disease or injury-related malnutrition and chronic disease-related malnutrition are capable of inducing disease-related sarcopaenia.

As an example, patients with chronic heart failure may experience the complications of chronic disease-related malnutrition (disease-related sarcopaenia) and disuse muscle atrophy (activity-related sarcopaenia) (22). Intensive care unit-acquired weakness (ICU-AW) in critically ill patients is defined as clinically detected weakness for which there is no plausible aetiology other than their critical illness (23). ICU-AW is multifactorial: both direct (critical illness neuromyopathy) and indirect (immobility/disuse atrophy) complications of critical illness contribute to ICU-AW (24). As 141 patients had acute disease or injury-related malnutrition, some of these patients with hospital-associated deconditioning may be diagnosed as having ICU-AW.

Elderly patients with hospital-associated deconditioning may experience age-, activity-, nutrition-, and disease-related sarcopaenia. Therefore, nutritional intervention in hospital-associated deconditioning is very important. Evidence suggests that maintaining protein intake during a period of disuse attenuates muscle disuse atrophy (25). Furthermore, supplementation with dietary protein and/or essential amino acids can be applied to further aid in muscle mass preservation during disuse (25). A combination of resistance exercise and nutrition seems to be potential therapeutic countermeasures against disuse muscle atrophy (26).

Cardiovascular and gastroenterological diseases had a similar low Barthel Index score at referral, lower MNA-SF score, lower Alb level, and higher CRP value. In contrast, we found that the MNA-SF score was higher and the CRP value lower in patients with kidney and urological diseases. These results indicate that the severity of hospital-associated deconditioning is more serious in cardiovascular and gastroenterological diseases than in kidney and urological diseases. However, the Barthel Index score at discharge was not significantly different between cardiovascular and gastroenterological diseases and kidney and urological diseases. This may be due to similar Alb levels and lower Hb levels in kidney and urological diseases resulting from renal anaemia.

The MNA-SF score was lowest in psychiatric diseases, partly because MNA-SF included questions on psychological stress in the past 3 months and neuropsychological problems. These questions may result in the MNA-SF score being lower in patients with psychiatric diseases. On the other hand, in patients with psychiatric diseases Alb level was highest and CRP value lowest, in association with fewer acute diseases or injury-related malnutrition. Therefore, the Barthel Index score at discharge was highest in psychiatric diseases, although this increase was not statistically significant.

This study has some limitations. First, as there are no validated criteria or guidelines for diagnosing hospital-associated deconditioning, its diagnosis may be different among physiatrists. Secondly, the diagnosis of starvation-related malnutrition might be inaccurate, because we did not use indirect calorimetry. Thirdly, because MNA-SF tends to underestimate nutritional status in the rehabilitation setting (27), the proportion of patients with malnutrition may be falsely high. Fourthly, we did not assess comorbidities of diagnosis of causative diseases. Comorbidities can be confounding factors between malnutrition and rehabilitation outcome. Finally, the true number of patients with ICU-AW and sarcopaenia was unclear, since electrophysiological testing, muscle mass assessment, and muscle strength assessment were not performed.

In conclusion, malnutrition is very common in elderly inpatients with hospital-associated deconditioning, and is associated with poor rehabilitation outcome in these patients. Further research into the effect of nutritional intervention in hospital-associated deconditioning is warranted.

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