Annals of Rehabilitation Medicine

How much do disuse syndrome patients improve with convalescent rehabilitation? Assessment of improvement

--Manuscript Draft--

Manuscript Number:	
Full Title:	How much do disuse syndrome patients improve with convalescent rehabilitation? Assessment of improvement
Short Title:	FIM gains after rehabilitation in disuse syndrome
Article Type:	Original Article
Section/Category:	Geriatric rehabilitation
Manuscript Classifications:	1: Brain disorders; 4: Dysphagia; 6: Geriatric rehabilitation
Keywords:	Disuse syndrome; Rehabilitation; Malnutrition; Dysphagia; Functional independence measure (FIM)
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Manuscript Region of Origin:	JAPAN
Abstract:	Objectives: The purpose of this study is to analyze the therapeutic effects of patients with disuse syndrome who underwent rehabilitation at a convalescent hospital. Methods: The subjects were 168 patients (87 male and 81 female) with disuse syndrome. The main diseases that resulted in disuse syndrome were COVID-19 in 13 cases, respiratory disease in 91, gastrointestinal disease in 24, urinary disease in 13, cardio-vascular disease in 11, and others in 16 cases. We investigated the relationship between the degree of FIM gain and etiology, age, gender, history of cerebrovascular disease, dementia, body weight, body mass index(BMI), hemoglobin, protein, albumin, prognostic nutritional index(PNI), malnutrition and dysphagia. Results: The average FIM-total gain by age decreased as age increased. FIM-total gain was 8.0 for the patients in their 90s. FIM-total gain was13.8 for those with no past incident of cerebrovascular diseases, 7.6 for one past incident, and 4.0 for two or more past incidents. FIM-total gain of the patients of severe dysphagia was significantly lower than that of the patients of normophagia / mild or moderate dysphagia. There was mild correlation between FIM-total gain and gain of body weight (r=0.21) and between FIM-total gain and gain of BMI (r=0.21). Conclusions: It is desirable that gain of body weight and BMI and the improving of dysphagia are necessary for the rehabilitation of patients with disuse syndrome. Patients with disuse syndrome over 90 years old or with two or more incidents of cerebrovascular diseases should be treated, not in rehabilitation but in nursing care.
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Question	**Response**
Funding Information:	
Author Comments:	

Jan 17, 2024

Annals of Rehabilitation Medicine

Editor-in-Chief
Prof. Dr. Byung-Mo Oh
Seoul National University, Korea

Dear Dr. Byung-Mo Oh：

We submit an original article entitled " How much do disuse syndrome patients improve with convalescent rehabilitation? Assessment of improvement " It is ordinal, is not currently under consideration nor has been accepted for publication elsewhere. All authors have contributed significantly to the content of the article. All authors have read and approve the submission of the manuscript to " Annals of Rehabilitation Medicine." Subject to acceptance, authors will sign an exclusive license to publish. There is no ethical problem, no conflict of interest nor publication ethics. We would like to have the paper published in Annals of Rehabilitation Medicine.

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Thank you for your consideration.

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How much do disuse syndrome patients improve with convalescent rehabilitation?

Assessment of improvement

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A running title: FIM gains after rehabilitation in disuse syndrome

Abstract

Objectives: The purpose of this study is to analyze the therapeutic effects of patients with disuse syndrome who underwent rehabilitation at a convalescent hospital.

Methods: The subjects were 168 patients (87 male and 81 female) with disuse syndrome. The main diseases that resulted in disuse syndrome were COVID-19 in 13 cases, respiratory disease in 91, gastrointestinal disease in 24, urinary disease in 13, cardio-vascular disease in 11, and others in 16 cases. We investigated the relationship between the degree of FIM gain and etiology, age, gender, history of cerebrovascular disease, dementia, body weight, body mass index(BMI), hemoglobin, protein, albumin, prognostic nutritional index(PNI), malnutrition and dysphagia.

Results: The average FIM-total gain by age decreased as age increased. FIM-total gain was 8.0 for the patients in their 90s. FIM-total gain was13.8 for those with no past incident of cerebrovascular diseases, 7.6 for one past incident, and 4.0 for two or more past incidents. FIM-total gain of the patients of severe dysphagia was significantly lower than that of the patients of normophagia / mild or moderate dysphagia. There was mild correlation between FIM-total gain and gain of body weight (r=0.21) and between FIM-total gain and gain of BMI (r=0.21).

Conclusions: It is desirable that gain of body weight and BMI and the improving of dysphagia are necessary for the rehabilitation of patients with disuse syndrome. Patients with disuse syndrome over 90 years old or with two or more incidents of cerebrovascular diseases should be treated, not in rehabilitation but in nursing care.

Keywords: Disuse syndrome; Rehabilitation; Malnutrition; Dysphagia; Functional independence measure (FIM)

INTRODUCTION

Disuse syndrome is defined as a "secondary disorder caused by a state of inactivity." [1] Many human functions are weakened due to bed rest, even if they are not due to disease, and further rest leads to pathological functional decline, resulting in a secondary complications.

Aging populations in the world are increasing, and elderly people account for more than 25% of the population in Japan. Everyone wishes for a healthy retirement, but people spend more than a couple of years at the end of their lives being bedridden. It is important for everyone to spend those years with peace of mind. Such many elderly people suffer from disuse syndrome at the end of life. It is caused by immobility and nutritional deficiencies, and those patients are in need of rehabilitation. Malnutrition is common in patients with the disuse syndrome [2]. For patients with disuse syndrome it is essential to improve not only just early mobilization and functional training but also their nutritional condition.

Rehabilitation is not always useful for some patients with disuse syndrome. Such patients require not rehabilitation but nursing care. By examining effects of rehabilitation for disuse syndrome in elderly people requiring severe care, we can consider an indication of the rehabilitation and also an indication of nursing care. The functional independence measure (FIM) is the most widely used standardized outcome measure for rehabilitation in the world. For improving effectiveness of the rehabilitation for patients with disuse syndrome, we should know first the detail of FIM gain based on the etiology and clinical factors.

In this article, to grasp a whole performance of the rehabilitation for patients with disuse syndrome, we determined characteristic of FIM gain after rehabilitation for them.

METHODS

This study was approved by Shimada Hospital Ethics Committee (No.2209). It was a retrospective research project and conducted at a single institution for patients with disuse syndrome who were hospitalized from May 2020 to November 2023. Finally, 168 patients were registered in the study (Table 1).

Eighty-seven patients were male and 81 were female. Their mean age was 83.2±8.7 (range 44 to 99). Main etiologies of disuse syndrome were COVID-19 in 13 cases, respiratory disease in 91 cases, gastrointestinal disease in 24 cases, urinary disease in 13 cases, cardio-vascular disease in 11 cases, sepsis in 5 cases, orthopedic disease in 5 cases, heatstroke/dehydration/hypothermia in 4 cases, and dementia in 2 cases. All patients received intensive rehabilitation by qualified physical therapists, qualified occupational therapists and qualified speech-language-hearing therapists. Patients were treated in the full-time integrated treatment (FIT) program [3] that is characterized by rehabilitation 7 days/wk, encouragement of daytime activity, and enhanced communication between staff. Patients who were 78 years or younger had 3 hours of professional rehabilitation (physical therapy 1 hour, occupational therapy 1 hour, speaking therapy 1 hour), and patients who were 79 years or older had 2 hours of professional rehabilitation (physical therapy 40 minutes, occupational therapy 40 minutes, speaking therapy 40 minutes). Several members of a nutrition support team (NST) improved the nutritional condition of the patients with disuse syndrome. Clinical and demographic features including main etiology, sex, age, history of cerebrovascular diseases, dementia, body weight (Kg), body mass index (BMI), serum hemoglobin [Hb

(g/dl)], serum total protein [TP (g/dl)], serum albumin [Alb (g/dl)], prognostic nutritional index (PNI), malnutrition and dysphagia were analyzed. PNI was calculated by 10 × Alb (g/dl) + 0.005 × total lymphocyte count (/mm³) [4]. Dysphagia is classified as follows: normophagia / mild dysphagia indicates that a patient can have a total oral diet at admission. Moderate dysphagia indicates that a patient cannot have a total oral diet at admission but can have it at discharge. Severe dysphagia indicates that a patient cannot have a total oral diet at admission and cannot have a total oral diet at discharge as well. Presence of malnutrition were defined as a BMI<18.5 kg/m^2, Hb level<10.0 g/dl, Alb level<3.0 g/dl, or total lymphocyte count<1200 cells/mm^3 [2].

Functional status was evaluated by using the functional independence measure (FIM). FIM was evaluated at admission, 4 weeks, 8 weeks after admission and discharge. The FIM items are broadly classified into total, motor and cognitive categories (FIM-total, FIM-motor, FIM-cognition). FIM scores were assigned according to a 7-point scale, and the score indicated the amount of assistance required to perform each item (7 = totally independent and 1 = totally dependent or not testable) [5].

Statistical Analysis

The data is presented as the mean ± standard deviation. A non-parametric test (Mann–Whitney U test) was applied to compare the mean value of the two groups. The statistical analyses were performed based on StatView for Windows (Version 5.0; SAS Institute Inc. Cary, NC, USA). A *p*-value of < 0.05 was defined as statistically significant.

RESULTS

The days until the start of rehabilitation was 6.8 ± 9.5 (range 0 to 62). and the days of

hospitalization in convalescent hospital was 51.9 ± 19.6 (range 7 to 100).

At admission FIM-total of all patients was 50.6±25.3 (range 18 to 112)., FIM-motor was 32.3±18.3 (range 13 to 79), and FIM-cognition was 18.2±8.7 (range 5 to 35). At discharge, FIM-total gain was 12.1±15.5 (range -18 to 80), FIM-motor gain was 10.9±13.7 (range -16 to 65) and FIM-cognition gain was 1.5±2.9 (range -4 to 17).

The averages of FIM-total by main etiology were 73.0±28.6 for cardio-vascular disease, 72.8±29.9 for heatstroke/dehydration/hypothermia, 65.4±19.4 for urinary diseases, 60.8±10.5 for orthopedic diseases, 56.0±28.1 for gastrointestinal diseases, 52.8±19.0 for sepsis, 51.7±24.5 for COVID-19, 50.0±33.9 for dementia, and 42.5±22.6 for respiratory diseases (Figure 1A). Patients with cardio-vascular disease or heatstroke/dehydration/hypothermia had higher FIM-total at admission. The averages of FIM-motor and FIM-cognition by main etiology were presented in Figure 1B and 1C.

At admission, the average was 47.4±12.5 for body weight, 19.8±4.2 for BMI, 11.5±1.7 for Hb, 6.5±0.7 for TP, 3.0±0.6 for Alb, and 36.6±6.2 for PNI.

The average of FIM-total gain at discharge by main etiology was 24.6±21.8 for COVID-19, 22.6±23.0 for cardio-vascular disease, 18.8±5.7 for heatstroke/dehydration/hypothermia, 13.4 for sepsis, 13.0±14.2 for dementia, 12.2±15.6 for orthopedic diseases, 12.1±11.5 for urinary diseases, 9.8±12.5 for gastrointestinal diseases and 9.3±14.1 for respiratory diseases (Figure 2A). Patients with COVID-19 or cardio-vascular disease had higher FIM-total gain at discharge. The average of FIM-motor gain and FIM-cognition gain at discharge by main etiology were presented in Figure 2B and 2C. Patients with cardio-vascular disease or dementia had higher FIM-cognition gain of 3 or more at discharge.

The average FIM-total at admission by age was 101.5 for patients in their 40s - 50s,

69.9 for those in their 60s, 49.9 for those in their 70s, 53.3 or those in their 80s, and 39.6 for those in their 90s, decreasing as age increased (Figure 3A). The average of FIM-total gain by age was 15.0 for patients in their 40s - 50s, 14.3 for those in their 60s, 14.4 for those in their 70s, 13.0 for those in their 80s, and 8.0 for those in their 90s, decreasing as age increased (Figure 3B). The average of FIM-cognition gain by age was 0.5 for patients in their 40s - 50s, 1.3 for those in their 60s, 1.3 for those in their 70s, 1.9 for those in their 80s, and 1.0 for those in their 90s. FIM-total gain of the females was 12.9 ±14.9, which is not significantly better than that (11.4±16.1) of the males. (p=0.546). Regarding the history of cerebrovascular diseases, FIM-total gain was13.7 for patients with no incident, 7.6 for one incident, and 4.0 for two or more incidents (Figure 3C); the more the history of cerebrovascular diseases, the lower the FIM-total gain. The average of FIM-total gain for the 75 patients with dementia was 11.0, which tended to be lower than the 13.0 for the 93 patients without dementia (Figure 3D). 139 patients (83%) were diagnosed with malnutrition. FIM-total gain at discharge of 139 patients with malnutrition was 11.8±15.9, which was likely to be worse than that (13.9±13.9) of the 29 patients without malnutrition, but there was not a significant difference (r=0.496).

Concerning the degree of dysphagia, FIM-total at admission of the patients of normophagia / mild dysphagia was 58.7±24.5, which was significantly higher than that (30.5±9.2) of the patients with moderate dysphagia or that (27.8±12.1) of the patients with severe dysphagia. FIM-total gain at discharge of the patients with severe dysphagia was 5.6±8.8, which was significantly lower than that (13.1±15.3) of the patients with normophagia / mild dysphagia or that (14.1±20.8) of the patients with moderate dysphagia.

There was a tendency for cases in which rehabilitation was introduced earlier to have

a higher FIM-total gain (Figure 5A). A tendency was observed that the longer the hospitalization period, the higher FIM-total gain (Figure 5B). There was an excellent relationship between FIM-total gain at discharge and FIM-total gain at 4 weeks after admission (r=0.89)（Figure 5C).

There were mild correlations between FIM-total gain and gain of body weight (r=0.21) (Figure 6A), and between of FIM-total gain and gain of BMI (r=0.21) (Figure 6B). There were not significant correlations between of FIM-total gain and gain of TP (r=0.045)（Figure 6C） or FIM-total gain and gain of Alb (r=0.016)(Figure 6D). There were no significant correlations between FIM-total gain and gain of Hb (r=0.084) (Figure 6E). There were no significant correlations between FIM-total gain and body weight at admission (r=0.13), between FIM-total gain and Alb at admission (r=0.16)（Figure 6F）. There was a mild correlation between FIM-total gain and PNI (r=0.19)（Figure 6G）.

DISCUSSION

Disuse syndrome is a pathological condition of both bed rest and undernutrition. It is very important to know the characteristics of disuse syndrome and to develop countermeasures against disuse syndrome. With the development of medical research in space in correlation with NASA since the 1960s, symptoms such as orthostatic low pressure, decreased cardiopulmonary function, and osteoporosis, similar to the disuse syndrome after long-term bed rest, have appeared after short-term spaceflights [1]. The negative effects of not exercising have been demonstrated [1].

Early rehabilitation

There was a tendency for cases in which rehabilitation was introduced earlier to have a higher FIM-total gain. Nutritional and exercise therapy should be started very early after admission and adjusted to the level of inflammation and disease status [6]. Early rehabilitation was useful treatment for osteoporotic vertebral fractures to minimize the risk for disuse syndrome, maintain pre-injury ADL status, and reduce the medical costs [7].

Early rehabilitation was already recommended to be effective for stroke patients [8]. The Intercollegiate Stroke Working Party (ICSWP) recommended that stroke rehabilitation should begin 24-48 hours after a stroke and should be reviewed at six months [9]. Although patients with an early rehabilitation start had lower FIM admission scores than patients with a late start, patients with an early rehabilitation start experienced greater functional improvement [10]. There was a relationship between early start of rehabilitation and better functional improvement. [11]

Characteristics of factors:

A tendency was observed that the longer the hospitalization period, the higher FIM-

total gain. There was an excellent relationship between FIM-total gain at discharge and FIM-total gain at 4 weeks after admission (r=0.89). FIM-total gain at 4 weeks after admission was revealed to be a prognostic predictor of patients with disuse syndrome. At admission, patients with cardio-vascular disease or heatstroke/dehydration/hypothermia reveal to have higher FIM-total compared to other etiology. And the average FIM-total at admission by age reveals to have decreased according to age increase.

Patients with COVID-19 or cardio-vascular disease, having higher FIM-total gain at discharge, were good candidates for rehabilitation of disuse syndrome. The average of FIM-total gain by age were decreased as age increased. FIM-total gain of the patients with dementia tended to be lower than that of the patients without dementia. FIM gain decreased according to repeating incidents of cerebrovascular diseases. Patients with no history of previous cerebrovascular disease were good candidates for rehabilitation of disuse syndrome.

Malnutrition

Wakabayashi H, et al. [2] reported that 91% of patients with disuse syndrome were malnourished. In our series 83% of patients were malnourished. Malnutrition is common in patients with disuse syndrome. Rehabilitation outcome was better in patients with normal nutrition compared to malnourished patients (relative risk: 0.72, p=0.04) [2], although our data did not show a significant difference. There was not a significant correlation between FIM-total gain and gain of Hb (r=0.084) in this study, but hemoglobin levels were reported to be associated independently with rehabilitation outcomes (odds ratio 2.34, p=0.005) [2]. Patients with low hemoglobin levels and PNI at referral are more likely to have a poor rehabilitation outcomes [2]. In our study, there were mild correlations between FIM-total gain and gain of body weight (r=0.21),

between FIM-total gain and gain of BMI (r=0.21) and between FIM-total gain and PNI (r=0.19). However, there were no significant correlations between FIM-total gain and gain of protein (r=0.045), between FIM-total gain and gain of albumin (r=0.016), between FIM-total gain and body weight at admission (r=0.13) or between FIM-total gain and albumin at admission (r=0.16).

Dysphagia:

Dysphagia is one of the most prevalent and distressing symptoms among palliative care patients [12]. Dysphagia was found to be closely associated with malnutrition and sarcopenia [13]. A combination of cognitive dysfunction and a decrease in activity of daily living (ADL) influence the outcome of dysphagia [14]. In this study the patients of normophagia / mild dysphagia had 58.7±24.5 of FIM-total at admission and get 13.1±15.3 of FIM-total gain at discharge. The patients of moderate dysphagia had 30.5±9.2 of FIM-total at admission, and got 14.1±20.8 of FIM-total gain at discharge. However the patients of severe dysphagia had 27.8±12.1 of FIM-total at admission, but got only 5.6±8.8 of FIM-total gain at discharge. Our data revealed that improving dysphagia is very important for the patients with disuse syndrome.

Sarcopenia

Secondary sarcopenia is often observed in disuse syndrome. Evaluation and treatment of sarcopenia is also necessary. In 2010, the European Working Group on Sarcopenia in Older People published the following statement: “Sarcopenia is a syndrome characterized by a 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”[15].The Asian Working Group for Sarcopenia (AWGS) 2014 consensus defined sarcopenia as "age-related loss of muscle mass, plus low muscle strength, and/or low physical

performance"[16]. Subsequently, in October 2016, sarcopenia was included in the ICD-10 (M62.84) and was internationally recognized as a disease [17]. The term, sarcopenia, is a combination of the Greek word sarx, meaning muscle, and penia, meaning to lose. Muscle mass is reduced by about 1%–2% every year after age 50 [18,19]. Exercise and nutritional management are crucial for the prevention and treatment of sarcopenia [6]. Excessive bedrest and mismanagement of nutrition in medical facilities can lead to iatrogenic sarcopenia [15]. It has been reported that 14.7% of older patients who did not have sarcopenia before hospitalization had new onset sarcopenia at the time of discharge [20]. It is generally said that anti-gravity muscles such as plantar flexor strength and knee extensor strength are easily affected by bed rest, while foot dorsiflexion strength and upper limb strength are less affected. In other words, anti-gravity muscles begin to weaken due to the effects of bed rest from a very early stage, whereas muscles with few anti-gravity elements do not experience muscle weakness right away, and this effect is unlikely to appear unless bed rest is performed for a long period of time. LeBlanc et al.[21] had eight healthy men aged 19 to 52 in bed for 17 weeks and evaluated muscle atrophy and muscle strength. As a result, muscle atrophy was clearly observed in the lower limbs, and although there was no significant decrease in muscle strength in flexion and extension of the elbow joints, it was observed in extension of the knee joints and plantar flexion of the ankle joints. Grip strength is used as a simple and useful index that reflects the muscle strength of the whole body [22].

In recent years, “sarcopenia and dysphagia” have become a hot topic in several academic meetings and conferences of medical and healthcare professionals. The expression “dysphagia due to sarcopenia” was first introduced in 2005 [23] whereas the term “sarcopenic dysphagia” was first used in the paper published by Kuroda et al. in

2012 [24]. The prevalence of malnutrition and sarcopenia in physically disabled elderly patients who undergo rehabilitation is high [25]

Osteoporosis:

Greenleaf et al. [26] found that long-term bed rest reduces stress on bones in the longitudinal direction, allowing the body to interpret this as a state in which bone mass is no longer needed, promote the excretion of calcium and phosphorus, and initiate bed rest. It states that a decrease in bone density occurs after two weeks.

Indication of nursing care

From the viewpoint of cost benefit, 90 or more year-old patients with disuse syndrome, whose FIM-total gain was 8.0, could be treated in nursing care, not rehabilitation. Patients who had two or more incidents of cerebrovascular diseases with disuse syndrome, whose FIM-total gain was 4.0, could also be treated in nursing care, not rehabilitation.

Limitations

We have to keep in mind that the research had two limitations. First, it was a retrospective research project and was conducted at a single institution. Second, the number of patients of disuse syndrome was only 168. For a more accurate assessment, additional patients with disuse syndrome and longer follow-up studies are necessary.

CONCLUSIONS

In order to increase the degree of FIM improvement in patients with disuse syndrome, it is important to start rehabilitation early after the onset of symptoms, a sufficient hospitalization period is required, and it is desirable to improve body weight and BMI through dietary intake. Improving of dysphagia is very important for the patients with

disuse syndrome.

ACKNOWLEDGMENT

We appreciate many therapists who perform intensive rehabilitation for patients and who also evaluated the outcomes.

We also appreciate Dustin Keeling who aided in the proofreading of our research.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

FUNDING INFORMATION

None

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Figure legends

Table 1. Patients characteristics

Figure 1.

A: FIM-total at admission based on main etiology

B: FIM-motor at admission based on main etiology

C: FIM-motor at admission based on main etiology

Figure 2.

A: FIM-total gain at discharge based on main etiology

B: FIM-motor gain at discharge based on main etiology

C: FIM-cognition gain at discharge based on main etiology

Figure 3 A: FIM-total at admission based on age. B: FIM-total gain at discharge based on age.

C: Past history of cerebrovascular diseases. D: FIM-total gain at discharge based on dementia

Figure 4.

A: FIM-total at admission based on the degree of swallowing ability.

B: FIM-total gain at discharge based on the degree of swallowing ability

Figure 5.

A: FIM-total gain at discharge and days of rehabilitation introduction after onset

B: FIM-total gain at discharge and hospitalization period

C: FIM-total gain at discharge and FIM-total gain at 4 weeks after admission

Figure 6.

A:FIM-total gain at discharge and gain of body weight

B: FIM-total gain at discharge and gain of body BMI (Body Mass Index)

C: FIM-total gain at discharge and gain of protein

D: FIM-total gain at discharge and gain of protein

E: FIM-total gain at discharge and gain of hemoglobin

F: FIM-total gain at discharge and albumin at admission

G: FIM-total gain at discharge and PNI (prognostic nutritional index)

Table 1. Patients characteristics

Age	**44 ～ 99 （Mean±S.D. : 83.2±8.7）**				
Sex	**Male**	**87**	**Past history of cerebrovascular disease**	**No history**	124
	Female	**81**		**One time history**	42
Main Etiology	**COVID-19**	**13**		**Two or more times history**	2
	Respiratory disease	**91**	**Dementia**	**Positive**	75
	Gastrointestinal disease	**24**		**Negative**	93
	Urinary disease	**13**	**Discharge**	**Home**	94
	Cardio-vascular disease	**11**		**Hospital, institution**	73
	Sepsis	**5**		**Death**	1
	Orthopedic disease	**5**			
	Heatstroke/dehydration/ hypothermia	**4**			
	Dementia	**2**			