Short-term Changes in Activities of Daily Living and Physical Activity Level of Inpatients Undergoing Rehabilitation Treatment

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***Abstract*—Though increasing physical activity level is essential for health promotion, inpatients are known to experience a drop in physical activity. However, even short-term rehabilitation treatment is expected to improve Activities of Daily Living (ADL), but accompanying changes in physical activity levels are unknown. This study evaluated change over one week in the Barthel Index (BI) and physical activity level in inpatients undergoing rehabilitation treatment and investigated the correlations between variability in these factors. The BI and physical activity levels were measured twice with a one-week interval between measurements for eight inpatients undergoing rehabilitation treatment at Iwate Medical University Hospital, Japan. The number of steps and time spent walking increased significantly from the first measurement to the second. On the other hand, there was no significant difference in BI score between initial measurement and after one week. However, 4 out of 8 inpatients showed the BI improved, and there was no inpatient showed worsened BI. Also, there were no significant correlations between the BI score variability and variability in the number of steps or time spent walking. The results suggested that rehabilitation treatment improved ADL ability and increased physical activity level among inpatients, but that variability in these factors is not correlated. A future study with an increased sample size divided by medical conditions is necessary.**

Keywords-rehabilitation treatments; Barthel Index; activities of daily living; physical activity level.

I. INTRODUCTION

The Global Recommendations on Physical Activity for Health published by the World Health Organization in 2010 identified physical inactivity as the fourth leading risk factor for global mortality, and lack of activity is known to be involved in the recurrence or exacerbation of various illnesses [1]. Thus, increasing physical activity is essential for maintaining and promoting health (maintaining physical and cognitive functioning, preventing the development of new diseases, etc.) and prolonging lifespan [2][3].

The Japanese Association of Rehabilitation Medicine proposes that "rehabilitation treatment works to return function, overcome disability, and cultivate activity" [4]. In other words, providing rehabilitation treatment (physical therapy, occupational therapy, etc.) to patients with physical disabilities can improve physical functioning, Activities of Daily Living (ADL), and increase the quality of life. However, many inpatients were found to have low physical activity [5]. Therefore, even if the ADL temporarily improve during hospitalization for inpatients undergoing rehabilitation treatment and their physical activity does not simultaneously improve, patients may return to physical inactivity after discharge leading to decreased motor and cognitive functioning, falls, and the development or exacerbation of other illnesses.

Generally, physical activity is evaluated using the International Physical Activity Questionnaire or a similar survey or an activity monitor with an internal triaxial accelerometer [6][7]. Activity monitors are a particularly simple way to measure steps, activity calories, and activity type and are, therefore, used by many researchers and clinicians. The Barthel Index (BI) is one of the most common methods used in clinical settings to evaluate ADL.

In Japan, it is both medically and financially optimal for acute phase hospitals to discharge or transfer patients as quickly as possible. In fact, the average hospital stay at our facility is less than two weeks; however, inpatient care may be continued for patients for whom intensive rehabilitation treatment is found to be effective. In this system, evaluating the short-term ADL and physical activity level is vital to determine the efficacy of rehabilitation treatment. Therefore, this study evaluated the changes over one week in the BI and physical activity level of inpatients undergoing rehabilitation treatment and investigated the correlations between these factors.

In Section II, the method in this study is explained. The results are outlined and discussed in Section III. Conclusion and future work are described in Section IV.

II. METHODS

A. Participants

Participants were eight inpatients undergoing intensive rehabilitation treatment at Iwate Medical University Hospital, Japan. Table I presents the participants' physical characteristics. The main causes of hospitalization were cerebral hemorrhage (n=2), surgery for osteoarthritis of the hip (n=3), surgery for osteoarthritis of the knee (n=2), or surgery for cervical spondylotic myelopathy (n=1). All

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participants underwent at least two hours of rehabilitation treatment daily, including at least one hour of both physical therapy and occupational therapy. The main exercise therapies conducted in physical and occupational therapy were muscle strengthening exercises, aerobic exercise, joint range of motion exercises, and ADL training. The Ethical Review Board of the Iwate Medical University approved this study. Participants signed a consent form after receiving an oral and written explanation of the research.

B. Measurement

Physical activity levels were measured for all participants using small activity monitors with internal triaxial accelerometers (KSN-200, KISSEI COMTEC) two times with an interval of one week between the measurements. Physical activity was measured continuously for twelve hours from 8:00 a.m. to 8:00 p.m. Activity monitors were placed on the anterior surface of the sternum, right thigh, left thigh, right shin, and left shin (Figure 1). Activity monitors were fixed in place with a transparent adhesive film to prevent chafing. The attending physical therapist evaluated the current BI on measurement days of physical activity. The number of steps, activity calories, and activity type as calculated from the activity monitor were used as indicators of physical activity level. Concerning activity type, the eleven activities configured in the activity monitor were classified into walking, standing, sitting, or lying down, and the duration was calculated for each.

C. Statistical analysis

Data were presented as mean ± standard deviation. The differences in BI score, steps, activity calories and duration for each activity between the initial measurement and after one week was evaluated by the Wilcoxon signed-rank test. Also, correlations between the variability (the difference between initial measurement and measurement after one week) in physical activity and BI were analyzed by using the Spearman's rank correlation coefficient. A p-value of less than 0.05 was considered significant. Statistical analysis was performed using the Statistical Package for Social Sciences software, version 23.0, for Windows (SPSS Inc., Chicago, IL).

TABLE I. PARTICIPANTS' PHYSICAL CHARACTERISTICS

Characteristics	Sample
Sex (male/female)	3/5
Age (years)	66.3±8.1
Height (cm)	158.7±9.8
Weight (kg)	62.1±12.4
Body mass index (kg/m2)	24.8±5.5

TABLE II. DURATION FOR EACH ACTIVITY IN EACH INPATIENT

	Activity Time (min)							
	Walking		Standing		Sitting		Lying down	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
no. 1	4	50	5	38	546	541	160	78
no. 2	30	55	20	16	286	368	184	52
no. 3	27	39	20	31	366	328	260	291
no. 4	40	57	65	109	450	451	49	11
no. 5	0	50	153	100	341	377	209	189
no. 6	92	80	56	68	374	337	138	196
no. 7	16	62	15	31	313	304	24	131
no. 8	58	56	38	45	300	362	271	231
mean ±SD	33± 30.2	56± 12.1*	46± 47.8	54± 34.1	372± 87.3	383± 77.0	162± 90.2	147± 96.1

1st= initial measurement; 2nd = after one week; *p < .05 vs 1st.

III. RESULTS AND DISCUSSION

A. Comparison of the BI, steps, and activity calories

The steps increased significantly after one week compared to the initial measurement (P = .012). However, there was no significant difference after one week for BI score and activity calories (BI score: P = .063; activity calories: P = .208). Figure 2 shows a comparison of the BI, steps, and activity calories at the initial measurement and after one week.

B. Comparison of activity durations

Table II summarizes durations for each activity. Walking time increased significantly after one week compared to the initial measurement (P = .036). However, time spent standing, sitting, and lying down was not significantly different after one week (standing: P = .208; sitting: P = .779; lying down: P = .575).

C. Correlation between BI variability and variability in steps and walking time

There was no significant correlation between BI variability and variability in steps and walking time (Figure 3).

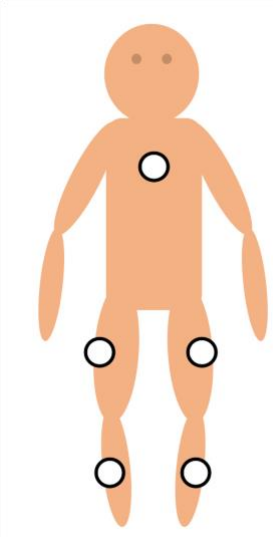

Figure 1. Sensor placement.

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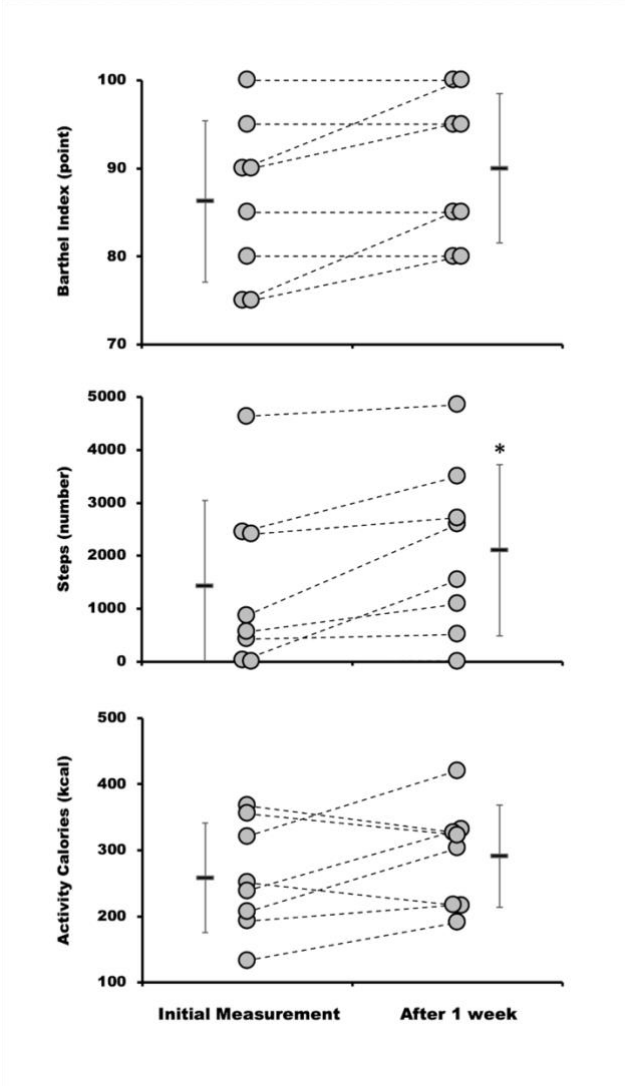

Figure 2. Comparison of values at initial measurement and after one week for Barthel Index, steps, and activity calories. Values are mean ± standard deviation; *p < .05.

This study found that both the number of steps and walking time increased over one week in inpatients undergoing intensive rehabilitation treatment. On the other hand, there was no significant difference in BI score between initial measurement and after one week. The best possible score of BI is 100 points, and all inpatients had got relatively high BI score at initial measurement. However, 4 out of 8 inpatients showed the BI improved, and no inpatient who showed a worsened BI. Also, the p value of BI between initial measurement and after one week was .063 in spite of small sample size. Therefore, we assume that to increase sample size will significantly improves BI.

Health Japan 21, a strategy for health promotion from the Ministry of Health, Labor and Welfare, proposed an increase in average steps per day. The National Health and

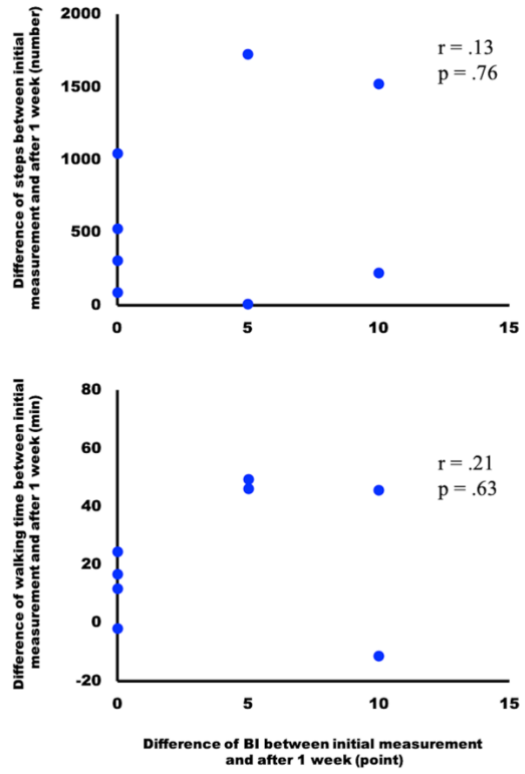

Figure 3. Correlation of increase in steps and walking time with Barthel Index improvement. Values are mean ± standard deviation.

Nutrition Survey conducted with community residents in 2010 found that men aged 65 and older took an average of 5628 steps/day while women aged 65 or older took 4585 steps/day. Thus, an increase of approximately 1500 steps/day is the goal for both men and women aged 65 or older [8]. Past research has found that inpatients are inactive [5], and although ADL ability improved and both steps and walking time increased over one week for inpatients in this study, BI variability and variability in steps and walking time were not correlated. This result suggests that improved ADL does not necessarily mean that the physical activity level will increase. In other words, rehabilitation treatment for inpatients should not focus solely on improving physical functioning and ADL, but must increase physical activity level for patients to lead a healthy and fulfilling life in the long-term after discharge. Specifically, besides medically controlling symptoms such as pain that inhibits physical activity, strengthening muscles and cardiopulmonary function, patient education, and environmental adjustments are essential approaches. Further, there are patients for whom ADL improves during hospitalization, but who become inactive after discharge, which leads to a decrease in ADL. Recognizing patients at risk for this and addressing it preemptively, is necessary. However, to the best of our knowledge, there are no studies that report such risk factors.

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In our previous work, we presented a data collection system in which movements are analyzed using Google Firebase service and a wearable device equipped with a gyrosensor [9][10]. Popularizing this system will lead to big data, which could potentially establish evidence of many issues from physical activity levels during hospitalization and after discharge. Further, existing activity monitors require professional staff and time to put on and can interfere with inpatient tests and bathing. As such, we believe there is a demand for a device capable of easily measuring physical activity levels.

This study has certain limitations. First, the number of subjects was relatively small. Second, physical activity was measured only once at each measurement, however, the reliability of data is unclear. Therefore, to further improve this study, it is important to measure physical activity several times a week for many patients who are divided according to their medical conditions.

IV. Conclusion and Future Work

In this paper, we evaluated change over one week in BI and physical activity levels in inpatients undergoing rehabilitation treatment and investigated the correlations between variability in these factors. One week of inpatient intensive rehabilitation treatment increased both steps and walking time. However, BI variability and variability in steps and walking time were not correlated. A future study with an increased sample size divided by medical conditions is necessary.

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