ORIGINAL ARTICLE

Impact of a Rehabilitation Protocol and a Dedicated Therapist in the Intensive Care Unit on Physical Function and Activities of Daily Living

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Objectives: The goal of this study was to determine the effects of an intensive care unit (ICU) rehabilitation protocol with dedicated therapists on the physical function and activities of daily living (ADL) of patients on discharge from the ICU. **Methods:** This retrospective study included patients who started rehabilitation during their ICU stay. Patients were divided into three groups: the Usual Care group (before the introduction of the rehabilitation protocol), the Protocol group (after the introduction of the rehabilitation protocol), and the PT + Protocol group (with a dedicated therapist in addition to the rehabilitation protocol). The standard interventions in the Protocol group and the PT + Protocol group were set according to the protocol based on the level of consciousness and strength of each individual patient. Patients' age, APACHE II score, length of ICU stay, length of hospital stay, and the Functional Status Score for the ICU (FSS-ICU) and Medical Research Council score (MRC score) on discharge from the ICU were compared among the three groups. **Results:** There were no significant differences among the three groups in age and APACHE II score. The MRC and FSS-ICU scores were significantly higher in the PT + Protocol and Protocol groups than in the Usual Care group. Furthermore, the lengths of ICU stay and hospital stay were lower in the PT + Protocol group than in the Usual Care group. **Conclusions:** Introduction of the rehabilitation protocol improved the limb strength and ADL of patients. Moreover, the presence of dedicated therapists in addition to the protocol reduced the lengths of ICU and hospital stays.

Key Words: activities of daily living; dedicated therapist system; intensive care unit; physical function; rehabilitation protocol

INTRODUCTION

Early rehabilitation in the intensive care unit (ICU) improves physical function, reduces delirium,[1] improves skeletal muscle strength,[2] improves quality of life,[3] and decreases lengths of ICU stay and hospital stay.[4] These findings have led to the recent establishment of early rehabilitation for patients in many ICUs. For safe and effective early rehabilita-tion of patients in the ICU, it is necessary to share medical information and to standardize medical practice among the multidisciplinary team that includes physical therapists (PT), occupational therapists, medical doctors, nurses, pharmacists, and medical engineering technicians.[5,6] To share medical information and standardize medical practice, the introduction of a rehabilitation protocol and the presence of dedicated therapists may be effective.

Morris et al.[7] reported that ICU interventions by a medical team using the protocol with patients lying in bed were safe and effective and resulted in shortening of ICU and hospital stays. Needham et al.[8] reported that creating an ICU team that includes dedicated physical and occupational therapists reduced the percentage of patients who received benzodiazepine sedatives on entering the ICU, reduced delirium within the ICU, improved the physical function and exercise capacity of patients, and shortened the ICU stay. These findings suggest that both the introduction of a rehabilitation protocol and the presence of dedicated therapists in the ICU may positively influence the improvement of physical function and shorten the ICU stay of patients.

In Europe, 75% of ICUs had at least one PT working exclusively in the ICU.[9] Most ICUs in Australia also have at least one senior PT on staff.[10] However, currently in Japan, only 16% of healthcare facilities reportedly have ICU protocols and only 18% have dedicated therapists in the ICU.[11] These findings suggest that dedicated therapists in the ICU and the introduction of rehabilitation protocols may not be common in Japanese ICUs.[11] The absence of ICU protocols and/or dedicated therapists in the ICU of many facilities in Japan may result from the difference in medical care system of the ICU and shortages of rehabilitation staff. As a result, it is still an issue whether to allocate a small number of rehabilitation staff to work in the ICU in each facility. It is important to examine the effects of implementing an ICU rehabilitation protocol with dedicated therapists as reference information so that medical institutions can make the decision whether to introduce a rehabilitation protocol and dedicated therapists in the ICU at each facility in Japan.

The goal of this study was to determine the effects of implementing an ICU rehabilitation protocol with therapists who are assigned to work in the ICU on the physical function and activities of daily living (ADL) of patients on discharge from the ICU.

MATERIALS AND METHODS

This study was a retrospective cohort study performed at the Kansai Electric Power Hospital in Osaka, Japan. Because of the retrospective nature of the study, an opt-out procedure for recruitment was instituted that allowed patients to withdraw from the study at any time. The study was conducted in accordance with the Declaration of Helsinki and was approved by the Kansai Electric Power Hospital Ethics Review Board (approval number: 28–23).

Subjects

This retrospective study included patients who were admitted to our emergency ICU (6 beds, semi-closed) for more than 48 h from July 2014 to June 2018 and who underwent rehabilitation in the ICU. We excluded patients who were diagnosed with orthopedic disease, central nervous system disease, or acute myocardial infarction and those who had undergone elective cardiovascular surgery, those with mental illness, those who required palliative care, those for whom rehabilitation was not indicated, those who were bedridden before hospitalization, and those who died during their ICU stay (**Fig. 1**).

Intensive Care Unit Rehabilitation Protocol

In July 2015, the ICU of our hospital started using the rehabilitation protocol developed by Morris et al.[7] Our hospital set the protocol level according to the patient's level of consciousness and voluntary muscular strength in the upper and lower limbs. **Figure 2** shows the method for determining the protocol level and details of the interventions.

Introduction of a Dedicated Therapist in the ICU

In March 2017, a dedicated therapist was assigned to the ICU in addition to the rehabilitation protocol that had been instituted in July 2015. The dedicated ICU therapist was defined as a therapist who worked in the ICU for a specified period of time conducting medical work. In the morning, the dedicated therapist sets the protocol level and intervention according to the protocol for each patient in the ICU; in the afternoon, interventions by a therapist other than the dedicated therapist and interventions by the ward nurse are performed.

Grouping of Patients

Subjects who were admitted between July 2014 and June 2015 (i.e., before introduction of the rehabilitation protocol in the ICU) were assigned to the Usual Care group, subjects admitted between July 2015 and February 2017 (i.e., after introduction of the rehabilitation protocol in the ICU) constituted the Protocol group, and subjects admitted between March 2017 and June 2018 with the presence of a dedicated therapist in addition to the rehabilitation protocol in the ICU made up the PT + Protocol group.

Data Collection

The age, gender, background information on ICU admission and progression of the underlying disease, the Acute
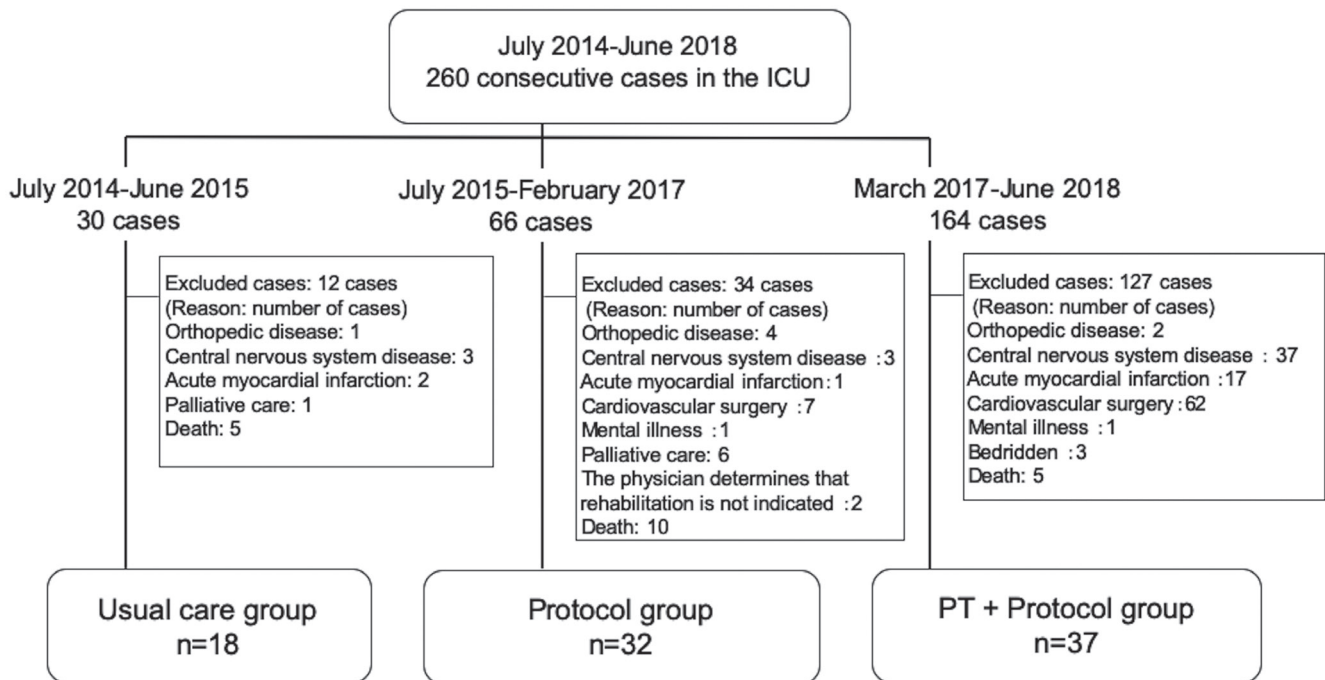
Fig. 1. Flowchart for selection of subjects in this study. PT, physical therapist.

Physiology and Chronic Health Evaluation (APACHE) II score, the percentage of patients using ventilators, the number days spent on a ventilator, and the percentage of patients with onset of delirium were obtained from medical records. Delirium was defined as a score of 4 points or more on the Intensive Care Delirium Screening Checklist (ICDSC),[12] evaluation of which was performed every morning.

The indices of progress of rehabilitation were the number of days from ICU admission to the day when the patient first underwent rehabilitation, first sat, first stood up, first walked, and first walked 100 m; the percentage of patients who could walk 100m; the length of time spent on rehabilitation per day while in the ICU, the number of standing or walking exercise sessions per day performed with a therapist while in the ICU; and the number of sitting and standing exercise sessions per day performed with a nurse while in the ICU. The mean time per day spent on rehabilitation was calculated as the sum of the times (in minutes) of all physical, occupational, speech, feeding, and swallowing therapies during the patient's ICU stay divided by the number of days of ICU stay of that patient. A session performed with a therapist or nurse was defined as one session when an intervention was performed, and the total number of sessions during the patient's ICU stay was divided by the number of days of ICU stay of that patient. A sitting or standing exercise with a nurse was defined as an exercise in which a nurse or doctor helped a patient perform sitting, standing, or wheelchair transfer.

As indices of physical function and ADL, the patient's Medical Research Council (MRC) score[13] and Functional Status Score for the ICU (FSS-ICU)[14] at the time of ICU discharge were assessed. We also analyzed the number of hospital days, the number of patients discharged from the ICU to home, and the Functional Independence Measure (FIM) of patients at the time of discharge from the hospital.
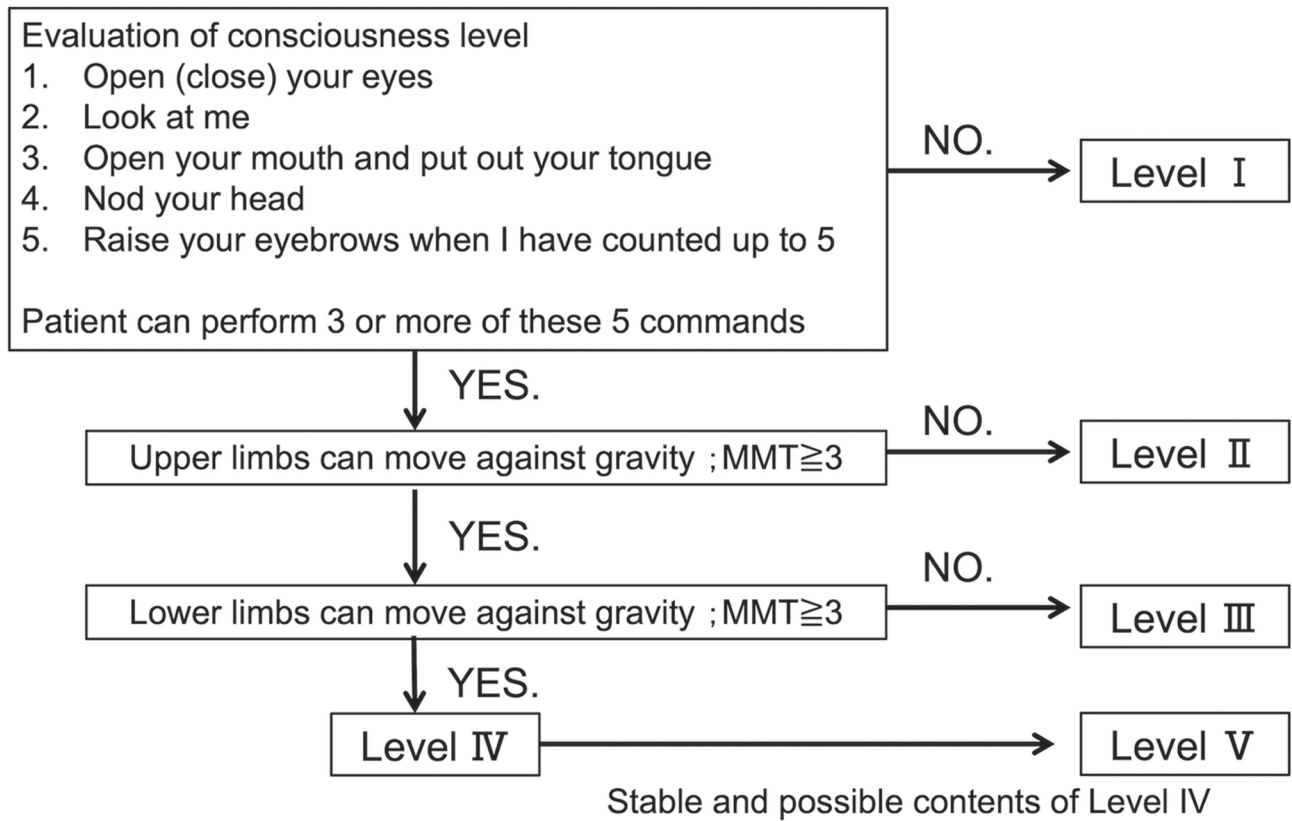
Data Analysis

Comparison between groups was performed using Fisher's exact test or one-way ANOVA and the Tukey test for multiple comparisons. For statistical analysis, the IBM Statistical Package for the Social Sciences version 22 was used. Significance was set at $P<0.05$.

RESULTS

Eighty-seven patients who were admitted to the ICU and met the study criteria were included in this study. Eighteen patients were classified in the Usual Care group, 32 in the Protocol group, and 37 in the PT + Protocol group (**Fig. 1**). There were no significant differences in age, APACHE II score, gender, underlying disease, percentage of ventilator users, and number of ventilated days among the three groups (**Table 1**).

The MRC score and FSS-ICU on discharge from the ICU were significantly higher in the PT + Protocol and Protocol

Evaluation of consciousness level
1. Open (close) your eyes
2. Look at me
3. Open your mouth and put out your tongue
4. Nod your head
5. Raise your eyebrows when I have counted up to 5

Patient can perform 3 or more of these 5 commands

→ NO. → **Level I**

↓ YES.

Upper limbs can move against gravity ; MMT≧3 → NO. → **Level II**

↓ YES.

Lower limbs can move against gravity ; MMT≧3 → NO. → **Level III**

↓ YES.

Level IV → **Level V**

Stable and possible contents of Level IV

	Level I	Level II	Level III	Level IV	Level V
Nurse	ROM exercise Ten repetitions per exercise. 2–3 times/ day	ROM exercise Sitting position 20 minutes 2–3 times/ day	ROM exercise Sitting position	ROM exercise Sitting position Sitting on the edge of the bed	Same as Level IV
Physical Therapist	ROM exercise	ROM exercise Sitting position	ROM exercise Sitting on the edge of the bed	Sitting position Sitting on the edge of the bed Standing Transfer to chair	Walking
Occupational Therapist		Evaluation of cognitive function	Evaluation of cognitive function	Environmental adjustment / ADL training	Walking
ADL			Dressing, eating meals, washing, cleansing	Transfer to a wheelchair, eating meals and dressing	Same as Level IV

Fig. 2. Method for setting the rehabilitation level and intervention content for patients in the ICU. MMT, manual muscle test; ROM, range of motion; ADL, activities of daily living.

Table 1. Patient characteristics and parameters reflecting patient progress in the ICU

	All subjects (n=87)	Usual Care (n=18)	Protocol (n=32)	PT + Protocol (n=37)	P value
Age (years)	74.7±11.4	78.4±6.1	76.6±11.5	71.2±12.5	
Gender (n)	Male 47	Male 9	Male 19	Male 19	0.744
	Female 40	Female 9	Female 13	Female 18	
Diagnosis (n)					0.067
Heart failure	24	2	9	13	
Acute respiratory failure	28	11	5	12	
Thoracoabdominal surgery	12	3	4	5	
Acute respiratory distress syndrome	4	0	2	2	
Interstitial pneumonia	4	0	3	1	
Sepsis	15	2	9	4	
APACHE II score	19.1±8.3	19.8±8.7	18.8±8.9	19.1±7.7	
Patients on ventilator (n, %)	44 (51%)	9 (50%)	16 (50%)	19 (51%)	0.981
Duration of ventilation (days)	3.4±6.8	6.5±12.1	3.1±4.8	2.2±4.3	
Patients with delirium (n, %)	51 (41%)	9 (53%)	12 (38%)	14 (38%)	0.518
ICU length of stay (days)	6.3±5.3	9.4±6.3*	6.5±5.5	4.5±3.9*	
Days to first rehabilitation	2.3±2.3	3.0±2.4	2.6±2.8	1.6±1.5	
Days to first sit	4.0±4.3	6.4±1.6*	4.2±3.4	2.6±2.9*	
Days to first stand	6.7±8.5	11.5±11.7*	7.8±9.2	3.4±3.4*	
Days to first walk	10.5±11.0	17.9±18.4*	10.5±8.2	7.3±6.6*	
Days to first 100-m walk	18.3±25.1	30.4±29.8*	20.6±31.9	10.6±8.2*	
Patients who could walk 100 m (n, %)	70 (80%)	13 (72%)	28 (88%)	29 (78%)	
Mean rehabilitation time per day (min)	28.2±21.5	12.4±6.7*	17.4±7.9†	45.1±22.7*, †	
Sessions per day of standing or walking by therapist	0.32±0.44	0.07±0.13*	0.19±0.24†	0.57±0.54*, †	
Sessions per day of sitting or standing by nurse	0.16±0.31	0.04±0.12*	0.05±0.15†	0.31±0.39*, †	
Discharge to home (n, %)	55 (63%)	8 (44%)	22 (68%)	25 (68%)	0.178
FIM at hospital discharge (points)	94.9±29.7	86.9±38.3	99.8±22.3	94.4±30.5	

Data are shown as mean±standard deviation.
PT, physical therapist; APACHE II score, Acute Physiology and Chronic Health Evaluation II score; FIM, Functional Independence Measure.
*P<0.05, Usual Care group vs. PT + Protocol group.
†P<0.05, Protocol group vs. PT + Protocol group.

groups than in the Usual Care group, and the length of hospital stay was greater in the Usual Care group than in the Protocol and PT + Protocol groups (**Fig. 3**).

There was no significant difference in the percentage of delirium cases among the three groups (**Table 1**). There were significant differences between the PT + Protocol group and the Usual Care group regarding the number of days required from ICU admission to the day of first sitting, first standing, first walking, and first walking a distance of 100 m. There was no significant difference in the number of days between ICU admission and the day of first rehabilitation or in the percentage of patients who could manage to walk 100m.

The rehabilitation time per day during the ICU stay was significantly longer in the PT + Protocol group than the Usual Care and Protocol groups. The daily number of standing/walking practice sessions by a therapist during the ICU stay and the daily number of sitting/standing practice sessions by a nurse during the ICU stay were significantly higher in the PT + Protocol group than in the Usual Care and Protocol groups. The percentage of patients who were discharged to home did not differ among the three groups. Moreover, the FIM at hospital discharge did not significantly differ among
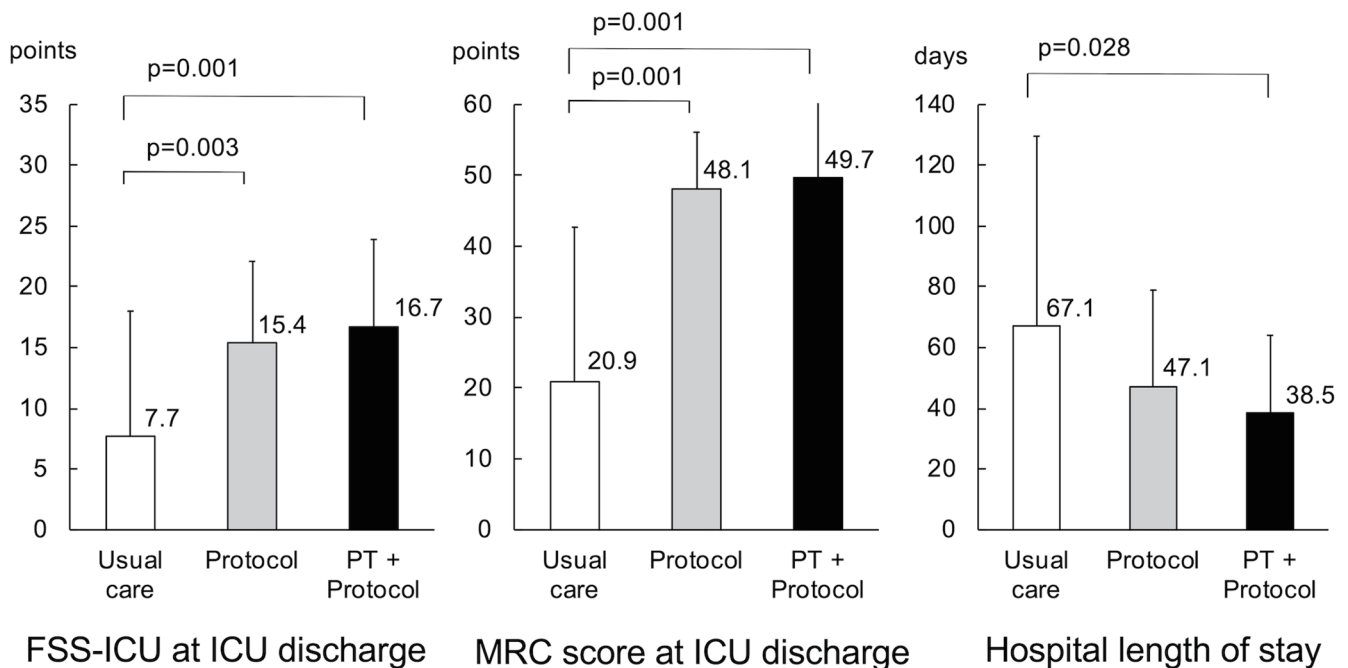
Fig. 3. Functional Status Score for the Intensive Care Unit (FSS-ICU) and Medical Research Council (MRC) score at ICU discharge and the length of hospital stay.

the three groups (**Table 1**).

DISCUSSION

This study was conducted to determine the effects of a rehabilitation protocol and the presence of a dedicated therapist on the physical function and ADL of patients on discharge from the ICU. Our findings indicated that introduction of the protocol improved the limb strength and ADL of patients on discharge from the ICU. In addition to the protocol, the assignment of a dedicated therapist reduced the lengths of stay in the ICU and the hospital.

In the current study, there were no significant differences among the Usual Care, Protocol, and PT + Protocol groups in terms of patient age, sex, underlying disease, APACHE II score, percentage of ventilator users, and number of ventilated days. Moreover, introduction of the rehabilitation protocol did not significantly affect the number of days between ICU admission and the day of first sitting or standing, nor the mean amount of rehabilitation time per day, but it did improve the limb strength and ADL of patients at discharge from the ICU. Drolet et al.[15] reported that the use of their ICU protocol increased the number of patients walking within 72 h after ICU admission and that the introduction of the protocol improved the physical function and ADL of ICU

patients. The appropriate organization of early rehabilitation protocols, setting similar skill levels for medical staff, and setting safe standards for the initiation and termination of early rehabilitation protocols are necessary to improve patient outcomes.[7,16–19] Introduction of the rehabilitation protocol may not in itself increase the number of rehabilitation interventions, but it is considered that with introduction of the protocol, patients' physical functions can be improved by implementing standardized interventions.

In this study, the presence of a dedicated therapist in the ICU in addition to introduction of the protocol reduced the number of days until the first standing/walking practice and increased the number of standing sessions and the time spent on rehabilitation activities. In addition to the interventions performed by the therapists, an increase in bed-leaving interventions such as sitting and wheelchair transfers facilitated by ICU nurses was observed. The additional intervention of a therapist other than the dedicated therapist in the PT + Protocol group was also a major factor in the increase of rehabilitation time. Moreover, it has been reported that healthcare teams need a promoter of the system.[6] The current study showed that introduction of the rehabilitation protocol and the presence of a dedicated therapist in the ICU promoted the protocol system, and, as a result, the protocol adherence rate by nurses in the ward and the frequency of patients getting

out of bed with the help of the nurse in the ward improved. Increased frequency and duration of rehabilitation and early bed-leaving reportedly improved patients' ADL and physical function and reduced the length of hospital stay and hospital costs.[20,21] Moreover, it has been reported that the presence of dedicated physical therapists at a surgical ICU shortened the ICU stay and improved the rate of home discharge.[22] Consequently, the presence of dedicated therapists in the ICU may be effective in improving the patients' levels of consciousness, rehabilitation, and mobilization.

Early rehabilitation in the ICU reportedly reduces the incidence of delirium[1,8]; however, in the present study, there was no significant difference in the percentages of patients with delirium among the three groups. In previous studies, the Confusion Assessment Method for the ICU for delirium and coma[1,8] was used for assessment of delirium, but in the present study, delirium was defined as an ICDSC score of 4 or more. This difference in the definition of delirium could have contributed to the difference in the results concerning reduction of the occurrence of delirium. Furthermore, pharmacologic and non-pharmacologic therapies for delirium are actively practiced in our hospital, and these aggressive interventions may positively affect delirium in all groups.

In the present study, introduction of the protocol and the presence of a therapist in the ICU did not affect the 100-m walking ability, the likelihood of patients being discharged to home, or the FIM at discharge from hospital of ICU patients. Early rehabilitation in the ICU is important, but how well the rehabilitation proceeds after ICU discharge is also important. We consider that the method and frequency of rehabilitation after discharge from the ICU are crucial and influence patients' ability to walk 100 m, the FIM score at hospital discharge, and whether the patient is discharged from the ICU to home. In the future, quantitative and qualitative evaluation of rehabilitation after ICU discharge will be necessary, and factors for improving ADL at the time of hospital discharge and methods of rehabilitation should be considered.

This study had the following limitations. The study was retrospective in nature, and although there was no significant change in the number of personnel, such as doctors and nurses, assigned to the ICU during the study period, the influence of diverse therapies on the outcomes cannot be completely eliminated. Although there were no major differences in the severity of illness in the subjects nor in the extent of ventilator usage, the diseases of the patients were diverse, and this fact may have influenced outcomes because of differences in the courses of specific diseases.

CONCLUSION

We studied the effects of the introduction of a rehabilitation protocol in the ICU and the presence of a dedicated therapist in the ICU on patients' physical function and ADL on ICU discharge. The introduction of a rehabilitation protocol improved the limb strength and ADL of patients at the time of ICU discharge, whereas the presence of a dedicated therapist in addition to the protocol reduced the lengths of ICU stays and hospital stays.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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