Cureus
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Open Access Case Report

Early Transition From Hospitalization for Diabetes Education to Outpatient Rehabilitation Under Japan's Long-Term Care Insurance System in a Patient With Type 2 Diabetes, Sarcopenia, and Diabetic Polyneuropathy: A Case Report

Ryota Shinomiya [1, 2], Yugo Sakai [1], Masaaki Nakajima [3]

1. Rehabilitation Department, Tokushima Kensei Hospital, Tokushima, JPN 2. Research Institute of Health and Welfare, Kibi International University, Takahashi, JPN 3. Department of Human Sciences, Major of Physical Therapy, Kibi International University, Takahashi, JPN

Corresponding author: Ryota Shinomiya, mugicha2.3.4.5@gmail.com

Review began 10/07/2026
Review ended 10/19/2026
Published 10/22/2026

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DOI: 10.7759/cureus.118370

Abstract

Older adults with type 2 diabetes mellitus (T2DM), sarcopenia, and diabetic polyneuropathy may have difficulty continuing exercise therapy independently after discharge. This case report describes the short-term course of glycemic control and physical function following an early transition from hospitalization for diabetes education to outpatient rehabilitation under Japan's long-term care insurance system. A 72-year-old woman with T2DM, sarcopenia, and diabetic polyneuropathy was admitted for a two-week diabetes education program. During a multidisciplinary discharge conference involving the patient, outpatient rehabilitation was considered necessary to support the continuation of exercise therapy after discharge. A care service coordination meeting was held six days after discharge, and outpatient rehabilitation was initiated 16 days after discharge. She attended outpatient rehabilitation once weekly for 80 minutes per session and performed low- to moderate-intensity exercise maintained at ⩽12 on the Borg scale. At three months after discharge, hemoglobin A1c had decreased from 9.1% to 5.9%. Handgrip strength, performance on the 30-second chair stand test, appendicular skeletal muscle mass index, and phase angle were maintained, without deterioration in body weight or nutritional status as assessed by the Geriatric Nutritional Risk Index. The six-minute walk distance increased by 25 m. This clinical course suggests that early transition from hospitalization for diabetes education to outpatient rehabilitation may support continued exercise therapy and diabetes management in older patients with T2DM who have difficulty exercising independently.

Categories: Physical Medicine & Rehabilitation, Geriatrics, Endocrinology/Diabetes/Metabolism
Keywords: diabetic polyneuropathy, long-term care insurance system, outpatient rehabilitation, sarcopenia, type 2 diabetes mellitus

Introduction

Type 2 diabetes mellitus (T2DM) is associated with reductions in lower-extremity muscle strength and skeletal muscle mass [1,2]. Muscle weakness develops relatively early in patients with T2DM, and diabetic polyneuropathy (DPN) is associated with further reductions in muscle strength [1,3]. Moreover, with the increasing number of older adults with T2DM, growing evidence indicates that T2DM is associated with an increased risk of sarcopenia [4], while coexisting sarcopenia is associated with higher mortality among older adults with T2DM [5]. In patients with T2DM, physical inactivity, malnutrition, obesity, age-related anabolic resistance, and chronic diabetic complications can interact to create a vicious cycle of declining muscle strength and skeletal muscle mass [6]. Therefore, maintaining or improving muscle strength and skeletal muscle mass is an important clinical priority in patients with T2DM, not only for preserving physical function but also from a prognostic perspective.

Recent evidence has also suggested that hyperglycemia may contribute to the loss of skeletal muscle mass [7]. Therefore, integrated support aimed at both improving glycemic control and maintaining or enhancing physical function is important for patients with T2DM. Hospitalization for diabetes education is one approach used to improve glycemic control [8]. In Japan, hospitalization for diabetes education is a short-term inpatient program that provides comprehensive diabetes management, including adjustment of pharmacological therapy and education on diet, exercise, and self-management. Glycemic control may improve during hospitalization because treatment is provided under the supervision of physicians and other healthcare professionals [8].

However, after discharge, follow-up is generally limited to periodic outpatient visits, and the implementation and continuation of exercise therapy may be particularly challenging for older adults. For patients with diabetes who do not meet the criteria for disease-specific rehabilitation under medical

insurance, rehabilitation may instead be provided through Japan's long-term care insurance (LTCI) system. Under this system, patients certified as requiring Support Levels 1 or 2 can receive outpatient rehabilitation as a preventive long-term care benefit, whereas those certified as requiring Care Levels 1-5 can receive outpatient rehabilitation as a long-term care benefit [9]. However, in a previous survey of rehabilitation users under the LTCI system, diabetes was the primary disease in only 0.3% of patients [10]. Because older patients with T2DM can experience accelerated declines in muscle strength and excessive loss of skeletal muscle mass [11,12], prompt and continuous care after discharge is considered important.

We encountered a patient with T2DM, sarcopenia, and DPN who transitioned to outpatient rehabilitation early after hospitalization for diabetes education. This report describes the short-term changes in glycemic control and physical function in this patient and may help healthcare professionals consider early coordination of outpatient rehabilitation to support continued exercise therapy after hospitalization for diabetes education.

Case Presentation

The patient was a 72-year-old woman with T2DM who was admitted to Tokushima Kensei Hospital for a two-week diabetes education program. Her height was 156.4 cm, body weight was 52.3 kg, and body mass index was 21.4 kg/m^2. She had a 20-year history of T2DM and stage 2 diabetic nephropathy. Her medical history included a surgically treated L2 vertebral compression fracture, rheumatoid arthritis, and Kellgren-Lawrence grade 4 osteoarthritis of the right knee. Throughout the observation period, the patient was receiving prednisolone 5 mg once daily, methotrexate 4 mg twice weekly, and celecoxib 200 mg twice daily for rheumatoid arthritis and pain management. She was also receiving bisphosphonate therapy for osteoporosis. Before admission, she had been certified as requiring Support Level 2 under the LTCI system. During the observation period, her certification was changed to Support Level 1. However, she was not using any long-term care insurance services before admission.

Before admission, she lived alone on the second floor of an apartment building. Although she was independent in activities of daily living, with a Barthel Index score of 100, she used a cane when walking outdoors because of right knee pain, which she rated as 8 on the Numerical Rating Scale. She had no regular exercise habits and led a predominantly sedentary lifestyle. Before hospitalization for diabetes education, her T2DM had been managed through outpatient follow-up; however, communication with her attending physician and other healthcare professionals was minimal. Her stage of change for exercise was classified as precontemplation based on her reported intentions and actual behavior, according to the transtheoretical model [13].

Assessment at admission

At admission, hemoglobin A1c (HbA1c) was 9.1%, fasting plasma glucose (FPG) was 288 mg/dL, serum albumin was 4.0 g/dL, and the Geriatric Nutritional Risk Index (GNRI) was 100.1. DPN was assessed based on the Japanese Clinical Practice Guideline for Diabetes [14]. The patient had numbness in both feet, absent bilateral Achilles tendon reflexes, and reduced vibration perception at the medial malleoli (2.95 seconds on the right and 6.16 seconds on the left). Based on these findings, DPN was determined to be present.

Regarding physical function at admission, usual gait speed was 0.90 m/s, handgrip strength was 13.3 kg on the right and 11.8 kg on the left, appendicular skeletal muscle mass index (ASMI) was 4.3 kg/m^2, phase angle was 3.2°, the 30-second chair stand test (CS-30) result was 7 repetitions, and the six-minute walk distance (6MWD) was 250 m. Usual gait speed was assessed using a 12-m walkway, with the time required to walk the central 6 m measured using a stopwatch. Handgrip strength was assessed twice on each side in the seated position with the arms at the sides using a Grip-D digital handgrip dynamometer (T.K.K. 5401; Takei Scientific Instruments Co., Ltd., Niigata, Japan), and the higher value for each side was recorded. ASMI, phase angle, fat mass, percent body fat, and the extracellular water-to-total body water ratio (ECW/TBW) were assessed by bioelectrical impedance analysis in the supine position using an InBody S10 device (InBody Co., Ltd., Seoul, Republic of Korea). Based on the Asian Working Group for Sarcopenia 2025 criteria [15], the patient was classified as having sarcopenia because she had low handgrip strength (<18 kg) and low ASMI (<5.7 kg/m^2). At three months after discharge, physical function and body composition were reassessed using the same procedures and equipment as those used at admission.

Intervention and clinical course

During hospitalization for diabetes education, comprehensive diabetes self-management education was provided in accordance with the hospital's clinical pathway. The physical therapist was responsible for exercise therapy and provided an overview of exercise therapy, assessed physical function, and instructed the patient in an individualized exercise program. At discharge, a multidisciplinary discharge conference was held with the patient, physician, and other healthcare professionals. The physical therapist judged that independently continuing exercise therapy after discharge would be difficult because of the presence of DPN and sarcopenia, reduced physical function, a sedentary lifestyle without regular exercise habits, right knee pain, a history of L2 vertebral compression fracture, and the challenges associated with living alone on the second floor of an apartment building.

During hospitalization, however, the healthcare professionals were able to provide sufficient time for individualized education and support, and the patient gradually became more communicative. She also began to express a positive attitude toward exercise therapy. For example, the patient and healthcare team established a shared goal of walking one lap around the ward whenever she went to the restroom, which she was able to accomplish. Furthermore, during feedback on the results of her physical function assessment, she expressed a desire to undergo another physical function assessment after discharge. In light of these behavioral changes, continued support from healthcare professionals after discharge was considered potentially beneficial. Therefore, at the multidisciplinary discharge conference involving the patient, the use of outpatient rehabilitation under the LTCI system was proposed.

The clinical course from admission to three months after discharge is shown in Figure *1*. Six days after discharge, a care service coordination meeting was held with the patient, a care manager from a designated care management office commissioned by the Community General Support Center, and staff from the preventive outpatient rehabilitation provider. Outpatient rehabilitation at a facility affiliated with our hospital was initiated 16 days after discharge.

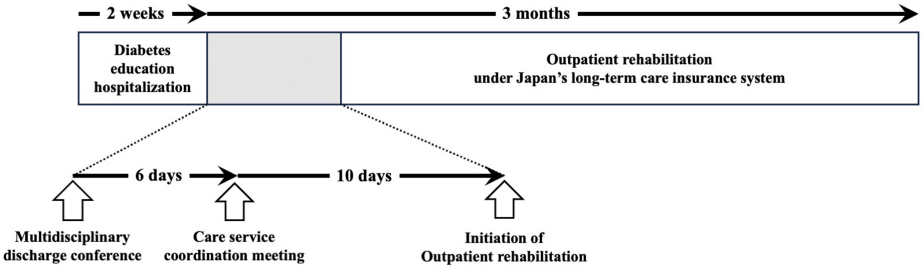


FIGURE 1: Clinical course from hospitalization for diabetes education to the initiation of outpatient rehabilitation.

The need for outpatient rehabilitation under Japan's long-term care insurance system was identified at the multidisciplinary discharge conference. A care service coordination meeting was held six days after discharge, and outpatient rehabilitation was initiated 16 days after discharge.

Regarding pharmacological and dietary therapy, the patient was receiving voglibose 0.2 mg three times daily and linagliptin 5 mg once daily at admission. Gliclazide 40 mg once daily was added on hospital day seven and was reduced to 20 mg once daily two months after discharge because of improved glycemic control; the reduced dose was continued through the end of the observation period. During hospitalization, dietary therapy providing 1,600 kcal/day (protein: 60 g/day, 1.15 g/kg/day) was implemented, and nutritional counseling was provided by a registered dietitian.

Outpatient rehabilitation was provided once weekly for 80 minutes per session. Each session included approximately 20 minutes of supervised exercise consisting of cycle ergometer exercise, sit-to-stand exercises, heel raises, standing hip flexion and abduction exercises, stair climbing, and gastrocnemius stretching using an inclined board; 20 minutes of supervised group exercises involving active movements of the upper and lower limbs in the seated position; and 20 minutes of individualized passive stretching, range-of-motion exercises, and manual resistance exercises. The remaining time was allocated to vital sign monitoring, rest periods, and individualized exercise counseling. Exercise intensity was monitored using ratings of perceived exertion and maintained at ⩽12 on the Borg scale. The frequency of outpatient rehabilitation was determined according to the patient's care plan under the LTCI system. The exercise volume and intensity were individualized based on her DPN, sarcopenia, right knee osteoarthritis with knee pain, baseline physical function, and the risk of hypoglycemia associated with gliclazide use, with priority given to safety and feasibility. Considering her history of L2 vertebral compression fracture and osteoporosis, she was instructed to avoid excessive trunk flexion and abrupt movements during exercise. Although the prescribed exercise volume was lower than that generally recommended for patients with T2DM, it was selected according to the patient's clinical condition and tolerance [14].

HbA1c progressively decreased after discharge, reaching 7.4% at one month, 6.0% at two months, and 5.9% at three months after discharge. FPG decreased from 288 mg/dL at admission to 97 mg/dL at one month after discharge and was 119 and 138 mg/dL at two and three months after discharge, respectively (Table *1*). No symptomatic hypoglycemic episodes were reported during the three-month follow-up period.

Parameter	Admission	1 month post-discharge	2 months post-discharge	3 months post-discharge
HbA1c (%)	9.1	7.4	6.0	5.9
FPG (mg/dL)	288	97	119	138

TABLE 1: Changes in HbA1c and FPG from admission to three months after discharge.

HbA1c = hemoglobin A1c; FPG = fasting plasma glucose

Physical function, activities of daily living, and nutritional indicators at admission and three months after discharge are presented in Table 2. Although right knee pain did not improve, ASMI, phase angle, CS-30 performance, handgrip strength, and usual gait speed were maintained. Body weight and the GNRI increased, while fat mass and percent body fat changed only slightly and ECW/TBW remained essentially unchanged. The 6MWD increased by 25 m. During the three months after discharge, the patient continued weekly outpatient rehabilitation without interruption and reported looking forward to the sessions. In addition, she became able to perform simple self-directed exercises at home, including calf raises, sit-to-stand exercises, and 700 m of outdoor walking. Accordingly, her stage of change for exercise progressed to the action stage.

Parameter	Admission	3 months post-discharge
Handgrip strength, right (kg)	13.3	13.3
Handgrip strength, left (kg)	11.8	12.1
Gait speed (m/s)	0.90	0.90
CS-30 (repetitions)	7	8
ASMI (kg/m²)	4.3	4.5
Phase angle (°)	3.2	3.4
6MWD (m)	250	275
BI	100	100
Body weight (kg)	52.3	54.1
Fat mass (kg)	23.8	24.4
Percent body fat (%)	45.5	45.0
ECW/TBW	0.411	0.409
Serum albumin (g/dL)	4.0	4.2
GNRI	100.1	104.4

TABLE 2: Changes in physical function, activities of daily living, and nutritional indicators from admission to three months after discharge.

ASMI = appendicular skeletal muscle mass index; CS-30 = 30-second chair stand test; 6MWD = six-minute walk distance; BI = Barthel Index; ECW/TBW = extracellular water-to-total body water ratio; GNRI = Geriatric Nutritional Risk Index

Ethical considerations

The purpose and objectives of this report and the protection of personal information were explained to the patient in writing and orally, and informed consent was obtained.

Discussion

This case report describes the short-term clinical course of a patient with T2DM complicated by sarcopenia and DPN who transitioned promptly from hospitalization for diabetes education to outpatient rehabilitation

under the LTCI system. A care service coordination meeting was held six days after discharge, and outpatient rehabilitation was initiated 16 days after discharge. HbA1c progressively decreased over the subsequent three months. In addition, handgrip strength, ASMI, and phase angle were maintained, and the 6MWD increased. These findings suggest that prompt and continuous post-discharge support may represent a useful strategy for patients with T2DM who have multiple complications and difficulty independently continuing exercise therapy.

Changes in glycemic control

HbA1c decreased substantially during the observation period. Because HbA1c reflects chronic glycemic exposure over the preceding two to three months [16], the reduction in HbA1c observed during the first two months after discharge was likely influenced substantially by the pharmacological therapy initiated during hospitalization, including the addition of gliclazide. FPG also decreased from 288 mg/dL at admission to 97 mg/dL at one month after discharge and was 119 and 138 mg/dL at two and three months after discharge, respectively. Gliclazide was subsequently reduced from 40 mg to 20 mg once daily two months after discharge, when HbA1c had decreased to 6.0%. Given the low frequency and modest intensity of the exercise intervention, the contribution of outpatient rehabilitation to the rapid reduction in HbA1c was likely limited, although some contribution of continued exercise cannot be excluded. Nevertheless, the respective contributions of pharmacological therapy, dietary management, outpatient rehabilitation, and behavioral changes could not be determined.

In addition, the HbA1c value of 5.9% at three months was below the recommended lower limit of 6.5% for older adults treated with medications associated with a high risk of hypoglycemia [17] and should not be interpreted solely as a favorable outcome. Although no symptomatic hypoglycemic episodes were reported, asymptomatic hypoglycemia could not be excluded because continuous glucose monitoring or systematic self-monitoring of blood glucose was not performed.

Changes in physical function

Although the follow-up period was limited to three months, limb muscle strength, as assessed by handgrip strength and the CS-30, as well as ASMI and phase angle, was maintained. Previous research has shown that lower-limb muscle strength may decline over a six-month period in older patients with T2DM who do not receive regular exercise guidance [18]. The present patient had both DPN and sarcopenia and had difficulty exercising independently; therefore, she was considered to be at particularly high risk of further declines in muscle strength and skeletal muscle mass. Nevertheless, at three months after discharge, HbA1c had decreased, while muscle strength and skeletal muscle mass were maintained.

Phase angle has been reported to reflect muscle quality and cellular health [19]. In the present case, phase angle was maintained, together with handgrip strength, CS-30 performance, and ASMI. In addition, body weight, serum albumin, and GNRI increased, while fat mass and percent body fat changed only slightly and ECW/TBW remained essentially unchanged. These findings suggest that muscle function was maintained without marked deterioration in body composition or nutritional status. This may indicate that the frequency and intensity of the exercise program were not excessive and were appropriate for this patient's clinical condition.

Exercise capacity was assessed using the 6MWD, which increased by 25 m. Although the minimal clinically important difference for the 6MWD has not been established in patients with T2DM complicated by DPN or sarcopenia, the observed increase exceeded the 17.8-m threshold reported in frail older Asian adults [20]. Therefore, although differences between the study populations should be considered, the change observed in this patient may have been clinically meaningful.

Conversely, outpatient rehabilitation was provided only once weekly. Considering the limited frequency of the intervention and the influence of knee pain, the amount of exercise provided may not have been sufficient in terms of the frequency, intensity, and duration generally recommended for exercise therapy in patients with T2DM. Therefore, the independent effect of exercise therapy on physical function may have been limited.

Nevertheless, the need for outpatient rehabilitation was identified during hospitalization for diabetes education, and a care service coordination meeting was held six days after discharge. This early multidisciplinary coordination facilitated the initiation of outpatient rehabilitation 16 days after discharge. In addition, the patient had already been certified under the LTCI system before hospitalization, which may have facilitated the early initiation of outpatient rehabilitation after discharge. The outpatient rehabilitation facility was affiliated with our hospital, which may also have facilitated information sharing and care coordination.

For this patient, who lived alone and had difficulty independently continuing exercise therapy, outpatient rehabilitation may have served not only as a setting in which exercise therapy was provided but also as an opportunity for regular outings, ongoing assessment of physical function, professional advice, and support for maintaining health-related behaviors. In addition, because her stage of change for exercise progressed,

continuity of support from hospitalization for diabetes education to post-discharge care may have contributed to behavioral change related to exercise. Thus, even though outpatient rehabilitation was provided only once weekly, establishing a regular source of support early after discharge may itself have had clinical significance.

Limitations

This case report has several limitations. First, because this is a case report, caution is required when generalizing the findings, and future studies involving larger numbers of patients are needed. In addition, because the patient had already been certified under the LTCI system before hospitalization, the rapid transition observed in this case may not be generalizable to patients who require a new LTCI certification after discharge. Second, the observation period was short. Given the increasing number of older adults with T2DM in Japan, longer-term follow-up is necessary to evaluate changes in muscle strength and skeletal muscle mass. Third, although a prompt transition from hospitalization for diabetes education to outpatient rehabilitation was achieved in this case, the frequency, intensity, and duration of exercise therapy were limited. Therefore, the dose-response relationship of exercise therapy provided during outpatient rehabilitation could not be evaluated. Fourth, pharmacological therapy was modified during the observation period, and the patient also transitioned from hospital-based dietary therapy to dietary management at home. Consequently, it was difficult to accurately assess dietary therapy after discharge. Therefore, the independent effects of exercise therapy provided during outpatient rehabilitation on glycemic control and physical function remain unclear. Because the hospitalization period was limited to two weeks, physical function and body composition were not reassessed at discharge. Therefore, changes occurring during hospitalization could not be distinguished from those occurring during the post-discharge outpatient rehabilitation period. Fifth, the patient demonstrated increased motivation and continued participation in outpatient rehabilitation after discharge; therefore, the findings may not be generalizable to patients with lower motivation or adherence.

Conclusions

A patient with T2DM complicated by sarcopenia and DPN transitioned early after discharge from hospitalization for diabetes education to outpatient rehabilitation under the LTCI system, with continued support for exercise therapy. Over the subsequent three months, HbA1c progressively decreased, while muscle strength, ASMI, and phase angle were maintained, and the 6MWD increased by 25 m. In addition, the patient's stage of change for exercise progressed from precontemplation to action. The clinical course of this case suggests that early transition from hospitalization for diabetes education to outpatient rehabilitation may have clinical value as a strategy for supporting patients with T2DM who have difficulty independently continuing exercise therapy.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Ryota Shinomiya, Masaaki Nakajima

Acquisition, analysis, or interpretation of data: Ryota Shinomiya, Yugo Sakai, Masaaki Nakajima

Drafting of the manuscript: Ryota Shinomiya

Critical review of the manuscript for important intellectual content: Ryota Shinomiya, Yugo Sakai, Masaaki Nakajima

Supervision: Masaaki Nakajima

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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