Original Article

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Effect of an Inpatient Rehabilitation Program for Recovery of Deconditioning in Hematologic Cancer Patients After Chemotherapy

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Objective To investigate the effect of a rehabilitation program in terms of De Morton Mobility Index (DEMMI) score, in hematologic cancer patients after chemotherapy.

Methods Hematologic cancer patients admitted for chemotherapy were reviewed. They received a rehabilitation program during their hospital stay. DEMMI score measurement was performed, before and after rehabilitation. Demographics, diagnosis, chemotherapy information, rehabilitation program duration, mortality, body mass index (BMI), and laboratory test results were collected. For analysis, patients were classified according to diagnosis (multiple myeloma, leukemia, and others), mortality, and additional chemotherapy.

Results There was statistically significant improvement in DEMMI score of 10.1 points (95% confidence interval, 5.9–14.3) after rehabilitation. It was more evident in the multiple myeloma group, and they revealed less mortality. When patients were divided according to mortality, survivors received the program earlier, and in a shorter period than in mortality cases. Although survivors revealed higher initial DEMMI score, improvement after rehabilitation did not differ significantly.

Conclusion In hematologic cancer patients, rehabilitation program was effective for recovery from deconditioning, revealing significant increase in DEMMI score. Multiple myeloma patients may be good candidates for rehabilitation. Rehabilitation could be sustained during chemotherapy and for high-risk patients.

Keywords Rehabilitation, Cancer, Hematology, Multiple myeloma

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INTRODUCTION

As survival of cancer patients increases, more patients return to social communities and plan for working lives. However, many cancer patients experience long-term physical and psychological deconditioning, after chemotherapy [1]. This makes it difficult to adapt to society, and maintain a good quality of life. To recover from this deconditioning, exercise is considered one of the most important interventions. Exercise in cancer survivors has been reported to increase body strength, reduce fatigue, and provide many other health benefits [2]. Even after chemotherapy, exercise is expected to resolve physical and psychological impairments [3,4]. Many studies, however, are focused on solid tumors, and there are only a few focused on hematologic cancers.

Because hematologic cancer affects blood, bone marrow, and lymph nodes, multiple body systems are damaged. In addition, hematologic cancer patients receive repetitive chemotherapy, with multiple agents and hematopoietic stem cell transplantation with immunosuppressive therapy [5,6]. This makes patients more vulnerable to opportunistic infections, cardiopulmonary deconditioning, and nutritional deficiencies [7]. Fatigue and pain also contributed, to reducing motivation for rehabilitation. After all, hematologic cancer patients undergo decreased physical fitness and mobility, as well as impaired health-related quality of life [8,9].

The need for comprehensive rehabilitation has been increasing in hematologic cancer patients. Recently, several studies revealed that exercise can be used safely and effectively in hematologic cancer patients [10,11]. A systematic review of exercise in cancer literature recommended exercise regardless of the type of cancer, to promote improvement in clinical and functional outcomes [12]. However, only ambulatory performance or muscle strength were measured in those studies, and exercise was prescribed uniformly across patients. Because each hematologic cancer patient has different safety concerns as well as varied functional status [13], appropriate programs should be applied clinically. The rehabilitation program should adapt to changing conditions of patients.

The purpose of this study is to investigate effects of a rehabilitation program on deconditioning after chemotherapy, using the precise functional score to present evidence of rehabilitation effectiveness in hematologic cancer patients.

MATERIALS AND METHODS

Participants

Cancer patients admitted to the Seoul National University Hospital and referred for rehabilitation from January 1, 2015 to December 31, 2017 were reviewed retrospectively. Among them, patients with hematologic cancer were included. Those that refused to participate in the rehabilitation program, or those whose De Morton Mobility index (DEMMI) score was not evaluated by the physical therapist at least twice, were excluded.

A total of 868 cancer patients were referred for physical therapy, and 158 were diagnosed with hematologic cancer. Finally, 62 patients were included in this study (Fig. 1).

The study was approved by the Institutional Review Board of Seoul National University Hospital (No. 1808-148-967).

Outcome variables

The DEMMI score was chosen as a tool of mobility evaluation [14]. The DEMMI is composed of 15 items, and to-

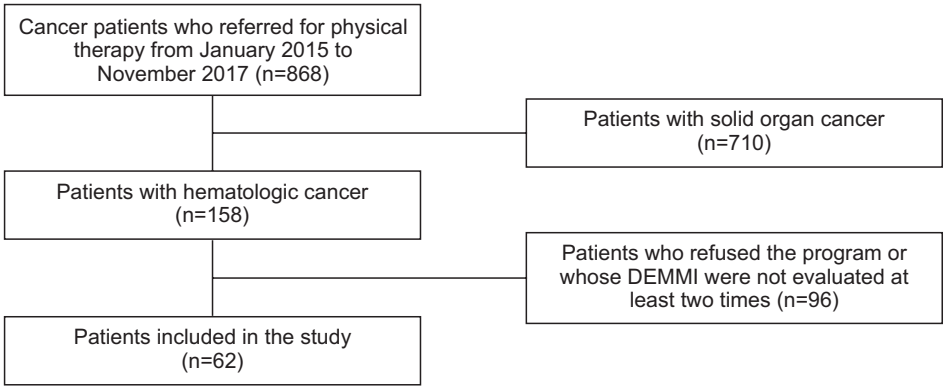

Fig. 1. Flow charts of patients. DEMMI, De Morton Mobility Index.

tal score ranges from 0 to 100 (Supplementary 1). Eleven items are scored 0 or 1, and four items are scored 0, 1, or 2. Items include bridging, rolling onto side, lying to sit, sitting unsupported, sitting to stand from chair, sitting to stand without using arms, standing unsupported, standing feet together, standing on toes, tandem standing, walking distance, walking assistance, picking up from floor, walking backwards and jumping. For all patients consulted for physical therapy, the DEMMI score was measured by the physical therapist at the beginning of the rehabilitation program, and again before discharge.

Duration of the rehabilitation program, and days from the start of the chemotherapy to the program were measured. Data about laboratory tests—hemoglobin, absolute neutrophil count (ANC), blood urea nitrogen (BUN), creatinine, and C-reactive protein (hsCRP)—and body mass index (BMI) were collected at the beginning of rehabilitation. Mortality was defined as all-cause mortality during the hospital stay. Whether patients received additional chemotherapy during rehabilitation program was recorded.

For analysis, patients were classified into three groups by diagnosis: multiple myeloma, leukemia, and others. The 'leukemia' group included acute myeloid leukemia, acute lymphoblastic leukemia, and plasma cell leukemia. 'Others' group included diffuse large B cell lymphoma, Burkitt lymphoma, T cell lymphoma, mantle cell lymphoma, and myelodysplastic syndrome. Numbers of patients diagnosed with 'multiple myeloma,' 'leukemia' and 'others' groups were 13, 22, and 27, respectively. Additionally, patients were divided into two groups, according to either mortality or additional chemotherapy.

Rehabilitation program

Hematologic cancer patients were referred to the department of rehabilitation after one cycle of chemotherapy. When patients complained of deconditioning or hematologic cancer and specialists found a decrement in physical function, the patient was referred to a rehabilitation physician. Based on careful evaluation of physical and medical status (i.e., vital sign, hemoglobin, and ANC), the rehabilitation physician decided about the time, place, and goal of an appropriate rehabilitation program. Usually, the program was performed in the gym. In case of patients at high risk of infection, bleeding, or shock, physical therapist visited the patient's room, and conducted the same program at bedside. According to the initial DEMMI score, patients received focused rehabilitation on impaired function for 30 minutes daily except weekends. The goal of the program was to go one step further than the highest functional level attained, in the initial DEMMI evaluation. If the patient's initial functional level was item #6 'sit to stand without using arms' in DEMMI evaluation, the goal was to perform item #7 'stand unsupported'. Functional level was re-evaluated by the physician once a week so that the level of the program was adjusted gradually.

For rehabilitation program, safety was considered top priority and every aspect of physical training was closely evaluated by the trained physical therapist considering hemoglobin, platelet, and ANC. The rehabilitation program started as soon as the rehabilitation physician prescribed it. The program consisted of a combination of stretching, strengthening, balance, and gait training. Stretching and strengthening training were performed, on all joints and muscles of upper and lower extremities. To improve bedside activities (i.e., item #1 to #4 in DEMMI), patients received balance of training in a sitting position. Standing balance and gait training were performed, to stand and walk with or without an aid, such as walker and cane. Dynamic balance training was performed once a stable static balance was observed.

All training courses were purposed to reach described goals. Detailed components were adjusted daily. For example, to reach the goal of item #7 'stand unsupported', lower extremity strengthening, and double leg balance training were selected as major components, so they were performed for a longer period. Because of limited program time, stretching or gait training was considered less important. If the goal was the item #12 'walking independence', lower extremity strengthening, standing balance, and gait training were major components, while stretching was considered relatively less important. Duration of the program was 24 days on average.

Statistical analysis

Baseline demographics and clinical characteristics were compared with use of the ANOVA or Student t-test for continuous variables and the chi-square test for categorical variables. To evaluate correlations between DEMMI score improvement and age, BMI, initial DEMMI, and rehabilitation program duration, Pearson correlation and

Spearman correlation analyses were used for continuous and categorical variables, respectively.

Two-sided p-values less than 0.05 indicated statistical significance. Statistical analyses were performed using SPSS version 21.0 (IBM SPSS, Armonk, NY, USA).

RESULTS

Mean age was 53.9 years and 37 patients (59.7%) were male. They presented physical deconditioning after chemotherapy revealing initial DEMMI score of 36.7 points (Table 1). There was significant improvement in the DEMMI score of 10.1 points (95% confidence interval, 5.9–14.3) after an average of 21 days of the rehabilitation program (Fig. 2). Patients were enrolled in the rehabilitation program, after a mean hospital stay of 20 days. There was no adverse event related to the rehabilitation program.

When patients were divided according to diagnosis, three groups revealed statistically different improvement in the DEMMI score (Table 2, Fig. 2). Mortality and BMI were also statistically different. The 'multiple myeloma' group revealed greatest improvement in the DEMMI score and highest survival among the three groups. Mean BMI of them was higher than the other groups.

Within an average of 44.5 days of admission, 23 patients (37.1%) died. Causes of death were neutropenic fever (8 patients), pneumonia (6), multi-organ failure due to disease progression (5), and others (cerebral hemorrhage, sudden cardiac arrest, invasive aspergillosis, etc.). There was no significant difference between the two groups: survivors vs. the dead. Survivors revealed higher initial DEMMI score and more improvement in DEMMI score than the dead, but was statistically insignificant (Table 3).

During the rehabilitation program, 16 patients (25.8%) underwent additional chemotherapy. Patients without additional chemotherapy revealed slightly higher DEMMI score improvement (11.5 points) than those with additional chemotherapy (6.2 points), but was statistically insignificant (not shown). Otherwise, there was no significant difference between the two groups.

There were no significant associations between DEMMI score improvement, and other factors (age, initial DEMMI score, BMI, and rehabilitation program duration).

Table 1. Demographics of hematologic cancer patients (n=62)

Variable	Value
Age (yr)	53.9 (49.6–58.3)
Sex, male	37 (59.7)
Diagnosis	
Multiple myeloma	13 (21.0)
Leukemia	22 (35.5)
Others	27 (43.5)
Initial DEMMI score	36.7 (30.3–43.0)
Improvement in the DEMMI score	10.1 (5.9–14.3)
BMI (kg/m^2)	21.2 (20.3–22.1)
Mortality (%)	23 (37.1)
Patients with additional chemotherapy (%)	16 (25.8)
Rehabilitation program duration (day)	21.2 (17.5–24.9)
Days from chemotherapy to rehabilitation	19.7 (14.3–25.1)

Values are presented as mean with 95% confidence interval or number (%).
DEMMI, De Morton Mobility Index; BMI, body mass index.

DISCUSSION

Approximately 70% of cancer patients experience cancer-related fatigue or physical impairment, after chemotherapy or radiotherapy [11,15]. Possible causes have been suggested by recent studies. Catabolic inflammatory factors produced by cancer may result in muscular or bony soft tissue changes, and chemotherapeutic agents may cause damage of muscle or peripheral nerve tissues

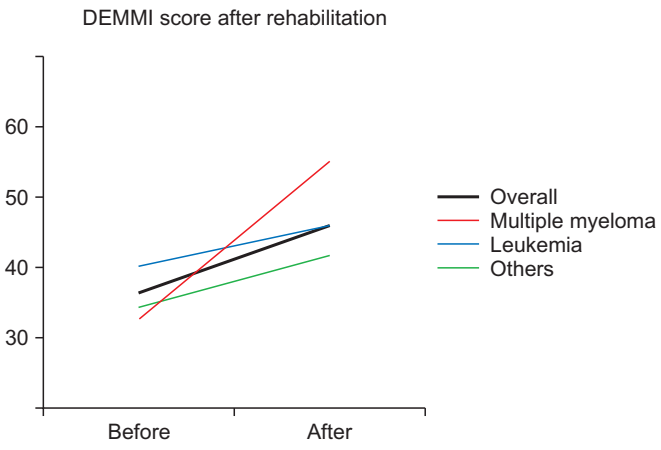

Fig. 2. Change of the De Morton Mobility Index (DEMMI) score improvement according to the diagnosis (n=62).

Table 2. Clinical characteristics according to diagnosis

Characteristic	Multiple myeloma (n=13)	Leukemia (n=22)	Others (n=27)	p-value
Age (yr)	61.4 (55.9–66.8)	50.0 (41.9–58.0)	53.6 (46.3–60.9)	0.16
Sex, male	8 (61.5)	12 (54.5)	17 (63.0)	0.83
Initial DEMMI score	33.5 (19.7–47.4)	40.7 (28.1–53.4)	34.9 (25.7–44.0)	0.64
Improvement in the DEMMI score	22.5 (10.0–35.1)	6.0 (0.4–11.5)	7.5 (1.7–13.2)	0.007**
BMI (kg/m^2)	23.7 (21.8–25.6)	22.0 (20.7–23.2)	19.4 (18.1–20.6)	0.000**
Mortality (%)	1 (7.7)	8 (36.4)	14 (51.9)	0.03*
Patients with additional chemotherapy (%)	4 (30.8)	6 (27.3)	7 (25.9)	0.95
Rehabilitation program duration (day)	19.0 (12.1–25.9)	17.8 (12.6–22.9)	25.2 (18.2–32.1)	0.18
Days from chemotherapy to rehabilitation	15.5 (1.9–29.1)	24.3 (13.0–35.7)	17.9 (11.3–24.5)	0.43
Laboratory test				
Hb (g/dL)	8.94 (8.37–9.51)	8.92 (8.40–9.44)	9.56 (9.08–10.03)	0.11
ANC (/μL)	1,499 (605–2,392)	3,173 (849–5,497)	3,717 (2,089–5,345)	0.30
BUN (mg/dL)	19.7 (9.6–29.8)	23.8 (17.1–30.5)	21.2 (16.0–26.3)	0.69
Cr (mg/dL)	0.77 (0.45–1.09)	0.94 (0.71–1.18)	0.69 (0.55–0.82)	0.15
hsCRP (mg/dL)	2.98 (0.92–5.03)	7.00 (4.51–9.50)	5.00 (2.52–7.50)	0.12

Values are presented as mean with 95% confidence interval or number (%).
DEMMI, De Morton Mobility Index; BMI, body mass index; Hb, hemoglobin; ANC, absolute neutrophil count; BUN, blood urea nitrogen; Cr, creatinine; hsCRP, human serum C-reactive protein.
*p<0.05, **p<0.01.

Table 3. Demographics and clinical characteristics according to mortality

	Survivor (n=39)	Mortality (n=23)	p-value
Age (yr)	54.0 (48.2–59.8)	53.8 (46.8–60.7)	0.96
Sex, male	20 (51.3)	17 (73.9)	0.08
Initial DEMMI score	41.0 (31.8–50.1)	29.4 (22.5–36.3)	0.08
Improvement in the DEMMI score	12.4 (6.6–18.3)	6.1 (0.5–11.7)	0.15
BMI (kg/m^2)	21.6 (20.4–22.7)	20.6 (19.1–22.0)	0.27
Patients with additional chemotherapy (%)	12 (30.8)	5 (21.7)	0.44
Rehabilitation program duration (day)	19.0 (14.6–23.4)	24.8 (17.9–31.6)	0.13
Days from chemotherapy to rehabilitation	16.7 (10.7–22.7)	24.7 (13.9–35.5)	0.16
Laboratory test			
Hb (g/dL)	9.25 (8.81–9.69)	9.12 (8.79–9.45)	0.67
ANC (/μL)	3,408 (1,846–4,971)	2,466 (1,191–3,741)	0.40
BUN (mg/dL)	21.5 (16.2–26.8)	22.3 (17.6–26.7)	0.83
Cr (mg/dL)	0.81 (0.64–0.98)	0.77 (0.63–0.92)	0.77
hsCRP (mg/dL)	4.56 (2.95–6.16)	6.53 (3.65–9.40)	0.19

Values are presented as mean with 95% confidence interval or number (%).
DEMMI, De Morton Mobility Index; BMI, body mass index; Hb, hemoglobin; ANC, absolute neutrophil count; BUN, blood urea nitrogen; Cr, creatinine; hsCRP, human serum C-reactive protein.

[16,17]. Cancer pain and increase in physical inactivity during hospital admission, also contribute to physical impairment. In addition, psychosocial and behavioral factors, as well as biological factors, may be associated with development and persistence of impairments [18]. Efforts to understand these underlying pathological processes, and apply them to cancer rehabilitation protocol are of major importance.

This study investigated effectiveness of rehabilitation in hematologic cancer patients, and revealed statistically significant improvement in the DEMMI score after the rehabilitation program. The DEMMI score as a mobility measurement tool enables estimation of physical function, roughly according to the score. Given increased total score from 36.7 to 46.8 points (approximately 8 to 11.5 points in raw score) in this study, it can be inferred that patients that could sit to stand without using arms, improved to walk with assistance. The difference of the score was 10.1 points, comparable to the minimal clinically important difference [19]. However, there was no correlation between DEMMI score improvement, and rehabilitation program duration. It is because patients whose functional recovery was slow, were treated for a longer period. This can be inferred from the result that there was a significant correlation between hospital stay, and rehabilitation program duration.

Functional improvement was more evident in the 'multiple myeloma' group than the other two groups revealing improvement by 22.5 points. This may be due to high survival rates of multiple myeloma, because survivors revealed slightly higher DEMMI score improvement. BMI of multiple myeloma patients could be another reason. Lower BMI is related with increased chemotherapy toxicity, or impaired functional status [20,21]. In addition, characteristics of multiple myeloma patients may have contributed to results. Coleman et al. [22] revealed that a home-based exercise program was effective in multiple myeloma patients, for increasing lean body weight and may be associated with decreased fatigue and mood improvement. Craike et al. [23] revealed that multiple myeloma patients tended to be interested in an exercise program, despite their low levels of physical activity, and Shallwani et al. [24] observed their high compliance with exercise. Multiple myeloma survivors often experience bone metastasis that can cause fracture and deformity, although there was no adverse event related to the program in this study. It is recommended to screen patients at risk for pathologic fractures, before starting a rehabilitation program.

Participants in this study revealed relatively high mortality (37.1%) during their hospital stay, meaning that severe patients were more likely to be included. Patients that died revealed slightly lower initial DEMMI score and BMI, than survivors. They revealed improvement in the DEMMI score, although it was lower than that of survivors. It is assumed that the rehabilitation program may be considered, in high-risk patients as well. Other studies support this, validating that an exercise program could improve physical activity, and quality of life even in palliative care [15,25].

Patients that received an additional cycle of chemotherapy during rehabilitation, did not quit the rehabilitation program. Their DEMMI score improvement was comparable, to that of patients without additional chemotherapy. Even though additional chemotherapy should cause physical deconditioning, patients maintained mobility. So, rehabilitation does not necessarily have to be stopped, during additional chemotherapy. Considering that initial DEMMI score was not associated with DEMMI score improvement, rehabilitation can also be considered in patients with low functional status.

Cancer rehabilitation is not a standard part of cancer treatment, although it is essential for delivery of high-quality oncology care [26,27]. For an inpatient cancer rehabilitation program, there are some issues that must be solved. First, physiatrists should understand cancer-related physical, psychosocial, or cognitive disabilities, and establish an appropriate treatment plan. Exercise barriers such as fatigue, physical deconditioning, and social isolation must be identified and practical strategies have to be adopted subsequently [28]. A well-defined referral system is also needed. In Korea, absence of a cooperative referral system was the major challenge in cancer rehabilitation [29]. By establishing a good referral system, cancer rehabilitation could begin at the time of diagnosis, and continue through the cancer care continuum.

There are several limitations in this study. First, a relatively small number of patients were included. Most of the patients able to walk independently after chemotherapy, refused to participate in the rehabilitation program, so they were provided with an education program only. Some severely ill patients also refused rehabilitation,

with doubt about benefits of the service. This reveals a lack of understanding about the effectiveness of cancer rehabilitation, and this is one of the most critical barriers [29]. So, only patients willing to engage in rehabilitation were included. In some patients, DEMMI score was not followed up because they discharged unexpectedly, or moved to other wards, without referral to the rehabilitation department. Second, there was no control group. It was difficult to recruit patients without rehabilitation, considering they were referred to the rehabilitation department for functional improvement. Third, the study was performed by retrospective chart review. Causal relationships could not be found, and there may be biases, that should be considered when interpreting the result. Finally, there was no assessment about fatigue, quality of life, and psychological disorders such as depression, anxiety, and insomnia. Further research would be required to find associations between these factors with functional improvement.

In conclusion, the rehabilitation program for hematologic cancer patients was effective, at improving functional outcome after chemotherapy. Among all patients, multiple myeloma patients may be good candidates for this program. The rehabilitation program can be maintained during chemotherapy, and used in high-risk patients.

CONFLICT OF INTEREST

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. 800-20180121).

SUPPLEMENTARY MATERIALS

Supplementary materials can be found via https://doi.org/10.5535/arm.2018.42.6.838. Suplementary 1. De Morton Mobility Index (DEMMI).

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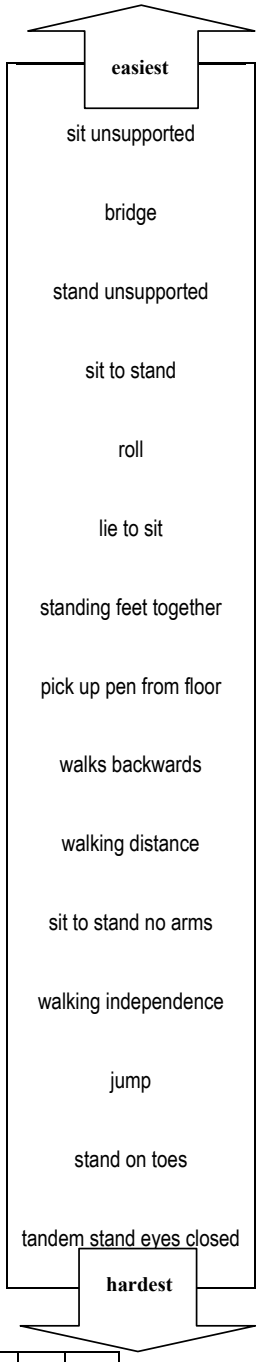
de Morton Mobility Index (DEMMI)

	0	1	2
Bed			
1. Bridge	☐ unable	☐ able	
2. Roll onto side	☐ unable	☐ able	
3. Lying to sitting	☐ unable	☐ min assist ☐ supervision	☐ independent
Chair			
4. Sit unsupported in chair	☐ unable	☐ 10 sec	
5. Sit to stand from chair	☐ unable	☐ min assist ☐ supervision	☐ independent
6. Sit to stand without using arms	☐ unable	☐ able	
Static balance (no gait aid)			
7. Stand unsupported	☐ unable	☐ 10 sec	
8. Stand feet together	☐ unable	☐ 10 sec	
9. Stand on toes	☐ unable	☐ 10 sec	
10. Tandem stand with eyes closed	☐ unable	☐ 10 sec	
Walking			
11. Walking distance +/- gait aid *Gait aid (circle): nil/frame/stick/other*	☐ unable ☐ 5m	☐ 10m ☐ 20m	☐ 50m
12. Walking independence	☐ unable ☐ min assist ☐ supervision	☐ independent with gait aid	☐ independent without gait aid
Dynamic balance (no gait aid)			
13. Pick up pen from floor	☐ unable	☐ able	
14. Walks 4 steps backwards	☐ unable	☐ able	
15. Jump	☐ unable	☐ able	
COLUMN TOTAL SCORE:			

RAW SCORE TOTAL (sum of column total scores) /19

DEMMI SCORE (MDC_{90} = 9 points; MCID = 10 points) /100



Raw-DEMMI Score Conversion Table

Raw Score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
DEMMI score	0	8	15	20	24	27	30	33	36	39	41	44	48	53	57	62	67	74	85	100

Comments:

Signature:_____ Date:_____

ITEM INSTRUCTIONS

Bed

1. Person is lying supine and is asked to bend their knees and lift their bottom clear of the bed.
2. Person is lying supine and is asked to roll onto one side without external assistance.
3. Person is lying supine and is asked to sit up over the edge of the bed.

Chair

4. Person is asked to maintain sitting balance for 10 seconds while seated on the chair, without holding arm rests, slumping or swaying. Knees and feet are placed together and feet can be resting on the floor.
5. Person is asked to rise from sitting to standing using the arm rests of the chair.
6. Person is asked to stand with their arms crossed over their chest.

Static Balance

7. The person is asked if they can stand for 10 seconds without external support.
8. The person is asked if, for 10 seconds, they can stand with their feet together.
9. The person is asked if they can stand on their toes for 10 seconds.
10. The person is asked to place the heel of one foot directly in front of the other with their eyes closed for 10 seconds.

Walking

11. Persons will be asked to walk with their current gait aid to where they can without a rest. Testing ceases if the person stops to rest. The person uses the gait aid that is currently most appropriate for them. If either of two gait aids could be used, the aid that provides the person with the highest level of independence should be used. Testing ceases once the person reaches 50 meters.
12. Independence is assessed over the person's maximum walking distance up to 50m (from item 11).

Dynamic Balance

13. A pen is placed 5 cm in front of the person's feet in standing. The person is asked if they can pick the pen up off the floor.
14. Walks backwards 4 steps. Person remains steady throughout.
15. Person can jump. Both feet clear the ground. Person remains steady throughout.

Definitions

Minimal assistance = "hands on" physical but minimal assistance, primarily to guide movement.
Supervision = another person monitors the activity without providing hands on assistance. May include verbal prompting.
Independent = the presence of another person is not considered necessary for safe mobility.

PROTOCOL FOR ADMINISTRATION OF THE DEMMI

1. Testing should be performed at the person's bedside.
2. Testing should be performed when the person has adequate medication eg. at least half an hour after pain or Parkinson's Disease medication.
3. The test should be administered in the sequence described in sections A-E: bed transfers, chair transfers, static balance, walking and dynamic balance.
4. Each item should be explained and, if necessary, demonstrated to the person.
5. Items should be ticked to indicate item success or failure. Reasons for not testing items should be recorded.
6. Items should not be tested if either the test administrator or the person performing the test are reluctant to attempt the item.
7. Persons should be scored based on their first attempt.
8. If an item is not appropriate given a person's medical condition, the item should not be tested and the reason recorded.
9. Persons can be encouraged but feedback should not be provided regarding performance.
10. Three equipment items are required: chair with 45cm seat height with arm rests, a hospital bed or plinth and a pen.
11. The person administering the test manipulates person medical equipment during testing (eg. portable oxygen, drips, drains etc) unless the person requires minimal assistance to perform the test and then a 2nd person will be required to assist with medical equipment.
12. For persons that require a rest after each item due to shortness of breath, a 10 minute rest should be provided half way through testing i.e. after completing the chair transfers section.
13. For person's who have low level mobility and require a hoist to transfer in/out of bed or chair, the chair section can be administered before the bed section for these persons.
14. **Bed transfers:** the bed height should be appropriate for the individual person. A standardised hospital bed or plinth should be used for testing. The person cannot use an external device such as the monkey bar, bed rail, edge of bed or a bed pole. Additional pillows may be provided for persons who are unable to lie flat in supine.
15. **Chair transfers:** A standardised chair height of 45cm is required. A firm chair with arms should be used.
16. **Balance:** Shoes cannot be worn for balance testing. The person cannot use external support to successfully complete any balance items. For sitting balance, neither the arm rests or the back of the chair can be used for external support. Standing balance tests should be performed with the person positioned between an elevated bed on one side and the test administrator on the other side. If a person displays unsteadiness or significant sway during testing, testing of that item should cease.
17. **Walking**: Appropriate shoes can be worn for walking tests. The same shoes must be worn for repeat testing.
18. **Scoring**: Using the conversion table provided, the raw score total must be converted to a DEMMI SCORE.

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