Availability of the Two-step Test to evaluate balance in frail people in a day care service

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Abstract. [Purpose] This study evaluated balance tests in users of a day care service who needed nursing care or support, and investigated the usefulness of the Two-step Test for evaluating balance. [Subjects and Methods] The subjects were users of a day care service, and had certified need for long-term care or support. All subjects were able to undergo the balance evaluations. Balance tests included the 3-m Timed Up and Go test (TUG), the one-leg standing time, and the Two-step Test. [Results] The Two-step Test and other balance tests were strongly correlated. [Conclusion] In this study of subjects who needed nursing care or support, the results were the same as in a previous study of subjects who did not need nursing care or support. The Two-step Test should be considered as an indicator of balance ability in elderly individuals requiring nursing care or support.

Key words: Two-step Test, Balance test, Day care service

INTRODUCTION

In Japan, aging has led to a rapid increase in the percentage of the population 65 years of age or older, and it is important to prevent dependency in this population. Major factors contributing to the loss of independence in the elderly include indoor and outdoor falls. The risk of falls can be reduced by taking preventive measures, with efforts promoted by both medical insurers and the long-term care insurance system. Among these efforts to prevent falls, balance and walking exercises are provided in rehabilitation programs. These exercises can also be provided in home-based rehabilitation and by day care service.

Evaluations of balance ability such as the one-leg standing time and the Timed Up and Go (TUG) test are performed in medical facilities to assess the risk of falling¹–⁶. However, evaluations focused on fall prevention are seldom performed under long-term care insurance or during home-based rehabilitation. Such evaluation methods can heavily burden frail people.

Accordingly, the Japanese Orthopaedic Association promoted the concept of “locomotive syndrome” to prevent dependency due to a musculoskeletal disorder, and began a prevention program⁷. Locomotive syndrome is defined as having a high risk of becoming dependent on nursing care due to a musculoskeletal disorder⁸, with a negative effect on personal independence⁹, ¹⁰.

The Two-step Test is easy to perform and has been promoted for assessment of the locomotive syndrome¹¹. The Two-step Test can be used to evaluate walking ability, muscular strength, balance ability, and lower limb flexibility, and is useful for predicting ability to walk.

The Two-step Test was found to be highly correlated with the 10-m-Walk Test, the 6-min Walk Distance, and the degree of independence in daily life¹². However, there are few reports on the relationship between the Two-step Test and other balance tests¹³. Furthermore, in almost all studies on the relationship between the Two-step Test and other balance tests, the
The study was conducted with the approval of the Kawasaki University of Medical Welfare Ethics Committee (approval number 16-013). The aims and methods of the study were explained to the participants and their families, and the study was conducted after securing their permission and willingness to participate voluntarily. The characteristics of the participants are shown in Table 1.

### RESULTS

The evaluation results for each subject are shown in Table 2. The average TUG test time and one-leg standing time, and the Two-step value are also shown. The correlation coefficients between measures are shown in Table 3. The correlation coefficient between the Two-step value and TUG test and the correlation coefficient between the Two-step value and one-leg standing time both showed a strong correlation.

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**Table 1. Characteristics of participants**

| Subject | Gender | Age | Level of nursing care# | Disease | Onset date* | Day care facility start date | Visits per week | Assistance for gait |
|---------|--------|-----|------------------------|---------|-------------|-----------------------------|----------------|-------------------|
| 1       | F      | 84  | Care level 1           | Hypertension | 3/4/2015   | 1 none                      |                |                   |
| 2       | F      | 77  | Care level 2           | Cerebral infarction | 9/9/2014 | 2/2/2015 | 2 none                      |                |                   |
| 3       | M      | 70  | Support level 2        | Chronic obstructive pulmonary disease | 7/26/2013 | 7/4/2015 | 2 none                      |                |                   |
| 4       | F      | 84  | Care level 1           | Left putaminal hemorrhage | 2/13/2009 | 10/2/2014 | 4 none                      |                |                   |
| 5       | M      | 87  | Care level 1           | Hypertension | 12/9/2014 | 1 none                      |                |                   |
| 6       | M      | 81  | Care level 2           | Parkinson’s syndrome | 11/15/2014 | 2 none                      |                |                   |
| 7       | M      | 74  | Care level 2           | Cerebral infarction | 8/11/2014 | 3/3/2015 | 3 none                      |                |                   |
| 8       | M      | 83  | Care level 3           | Renal failure, heart failure | 9/2014 | 3/3/2015 | 1 none                      |                |                   |
| 9       | M      | 80  | Care level 2           | Cerebral thrombosis | 11/11/2014 | 2 none                      |                |                   |
| 10      | F      | 86  | Care level 3           | Left femoral neck fracture | 6/16/2014 | 10/3/2014 | 3 T-cane                    |                |                   |
| 11      | M      | 75  | Care level 3           | Cerebral hemorrhage sequelae | 2/1997 | 7/27/2015 | 4 T-cane                    |                |                   |

#Level of nursing care determined by the long-term care insurance system. Patients apply for the care need assessment at the city office  
*Blank is unknown

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Oberg et al. reported that step length increases with an increase in walking speed\(^{19}\). Fujiwara et al. examined the similarity in kinematics between normal walking and front-stepping movement\(^{20}\). They showed that front-stepping movement could be generalized to walking, as each movement was similar to that in the ankle rocker period.

In a prior study by Sugawara et al., the Two-step value was significantly improved at four weeks after initial evaluation in inpatients with a cerebrovascular accident\(^{21}\). In their study, as the Two-step value approached 1.0, there was a shift toward independent walking ability; this can be used as a predictive target value for independence. Ninomiya et al. found a significantly low Two-step value in a group with diabetic polyneuropathy\(^ {22}\).

Muranaga et al. reported that fall risk increases when the Two-step value decreases; therefore, fall risk rises with a value less than 1.0. In this study, the average Two-step value was 0.85, indicating a higher risk of falling\(^ {2}\). Strong correlations between Two-step Test and TUG test values as well as Two-step value and one-leg standing time were shown in this study. In previous studies on the correlation between the Two-step Test and other balance tests in healthy elderly individuals who did not need nursing care or support, the Two-step value showed a correlation with the TUG and Functional Reach Test\(^ {14, 15}\). In this study, the result was the same in subjects who needed nursing care or support. Therefore, the Two-step Test can be used as an indicator of balance ability. For frail people, this balance test can be easily performed with little burden. Therefore, this test is useful for evaluating the balance ability of elderly individuals who require nursing care or support. Because the number of subjects was limited, we were not able to examine the effects of gender, comorbidity, age, etc., which require further study.

### DISCUSSION

**Table 2.** The evaluation results for each subject

| Subjects | TUG (seconds) | One-leg standing time (seconds) | Length of two steps (cm) | Two-step value |
|----------|---------------|--------------------------------|--------------------------|----------------|
| 1        | 9.67          | 0                              | 125                      | 0.83           |
| 2        | 9.67          | 30                             | 171                      | 1.07           |
| 3        | 8.2           | 30                             | 213                      | 1.24           |
| 4        | 9.6           | 4.03                           | 116                      | 0.78           |
| 5        | 15.72         | 5.02                           | 145                      | 0.86           |
| 6        | 11.25         | 18.72                          | 175                      | 1.07           |
| 7        | 9.78          | 30                             | 168                      | 1.04           |
| 8        | 11.5          | 0                              | 160                      | 0.94           |
| 9        | 14            | 3.35                           | 124                      | 0.78           |
| 10       | 21.3          | 0                              | 71.5                     | 0.46           |
| 11       | 47.28         | 0                              | 48                       | 0.31           |
| Average  | 15.27         | 11.01                          | 137.86                   | 0.85           |
| SD       | 11.26         | 13.30                          | 47.84                    | 0.27           |

TUG: Timed Up and Go test. Two-step value: length of two steps (cm)/height (cm)

**Table 3.** Correlations coefficients between measures

|                        | Two-step value | TUG         | One-leg standing time |
|------------------------|----------------|------------|-----------------------|
| Two-step value         | −0.82*         | 0.75*      |                       |
| TUG                    | −0.43          |            |                       |
| One-leg standing time  |                |            |                       |

\(*p<0.05\)

TUG: Timed Up and Go test

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