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Reliability of Physical Performance Measures in Nursing Home Residents With Alzheimer's Disease

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Abstract

Background—Investigation of the effects of exercise on frail, institutionalized individuals with dementia has been impeded by concerns about the reliability of physical performance measures when used in this population.

Methods—The physical performance of 33 institutionalized subjects with Alzheimer's disease was measured during both the morning and afternoon of day 1 by rater 1 and during both the morning and afternoon of day 2, one week later, by rater 1 and rater 2. Intraclass correlation coefficients (ICCs) were calculated to examine the inter-and intrarater reliability of "sit to stand," "25-foot walk," and "the distance walked in 6 minutes" and walking speed over 25 feet and for 6 minutes. An analysis of variance was performed to determine the components of variance for each test.

Results—ICCs for "distance walked in 6 minutes" ranged from .80 to .99 with 77% of the variance explained by inter-subject differences. The ICCs for "time to walk 25 feet" ranged from .57 to .97 with 25% of the variance explained by inter-subject differences. In contrast, the "sit to stand" measure produced ICCs ranging from −.07 to .85 with only 7% of the variance explained by inter-subject differences in this impaired population.

Conclusion—Our results support the contention that some physical performance measures can be used to test individuals in the later stages of Alzheimer's disease given appropriate modification. Although subjects with Alzheimer's disease may have difficulty following commands and/or require physical assistance, this does not prohibit the reliable assessment of physical performance if measurements are made over longer (6-minute walk) rather than shorter periods (25-foot walk).

An estimated 4 million Americans suffer from Alzheimer's disease (1). Three-quarters of the population with Alzheimer's and related dementias are eventually placed in long-term institutions (2), and their average stay is far longer than the national average for all diagnoses. The nursing home environment often encourages physical inactivity which leads to deconditioning and functional decline (3,4). Individuals with Alzheimer's disease are also less likely to be remobilized (5,6).

Interest in the effects of exercise in frail, institutionalized older adults has increased rapidly in the past few years (7–9). However, the majority of studies done to date have systematically excluded individuals with Alzheimer's disease. One of the reasons for their exclusion is uncertainty about the reliability of the measurement of outcomes in this patient population.

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This population presents special problems when testing physical performance. Alzheimer's disease produces a progressive deterioration in memory, judgment, and attention. Individuals with Alzheimer's disease may have aphasia or apraxia as well (10). Impaired balance, inability to follow directions, and apprehension related to training equipment are additional impediments to the measurement of physical performance (11). The purpose of this study was to examine the reliability of several established measures of physical performance in subjects with Alzheimer's disease.

METHODS

Subjects

As part of a larger study, 33 subjects were selected from the inpatient units of two long-term care facilities. They were screened by a psychiatrist and included in the study if they met the NINCDS-ADRDA criteria for moderate or severe Alzheimer's disease (12). Those with evidence of vascular dementia or history of stroke were excluded from the study. The psychiatrist determined competence to give informed consent based on clinical examination and testing of the subject's ability to understand the purpose and consequences of participating in the study. If declared competent, informed consent for participation in the study was obtained from the subject. If the subject was declared incompetent, informed consent was obtained from the next of kin. Subjects were excluded if they were unable to walk at least 10 feet at the time of admission to the study.

Physical Performance Measures

Timed "Stand and Walk"—The "Stand and Walk" test is a modification of the timed "Get-up and Go." The "Get-up and Go" is a test of balance and basic mobility designed for use with elderly subjects (13,14). In the "Get-up and Go" the subject is asked to rise from a chair, walk 10 feet and turn and return to the chair. We initially attempted to use this form of the test. However, we were forced to make several modifications because many individuals with moderate to advanced Alzheimer's disease have difficulty rising from a chair and/or have difficulty understanding and following verbal commands. Therefore, we allowed the examiner to use any combination of verbal persuasion, physical cueing, and physical assistance required to get the subject to stand up from the chair. Because it was so difficult to get subjects to stand up on command, we chose to perform all the tests involving walking immediately after measuring the time required to stand up from the chair. Therefore, we were forced to eliminate the turn and return to the chair. The "Stand and Walk" requires the subject to rise from a chair, with or without assistance, and walk forward 25 feet. Both the time required to rise from the chair and the time required to walk 25 feet were recorded separately. Timing for the chair-stand portion of the test began when the subject shifted weight forward to stand up and ended when the subject was fully erect. Timing for the walking portion of the test began when the subject stepped away from the chair and ended when the subject crossed a line 25 feet from the starting point. We measured the time elapsed during the chair stand and ambulation portions of the test using multiple stop watches. We used a calibrated surveyor's measure wheel (15) to measure the 25-foot distance.

Six-Minute Walking Test—McGavin et al. (16) and Butland et al. (17) modified the original 12-minute walking test to create a 6-minute walking test which could be used to estimate $\dot{V}O_2$max in disabled populations (13). This test assumes that the subject is able to ambulate without physical assistance or the use of an assistive device. We were again forced to modify this test in several ways for use in a dementia population. Many institutionalized individuals with moderate to severe Alzheimer's disease have impaired balance and require physical assistance to ambulate safely. Some individuals may also require the use of an assistive device, usually a wheeled walker. Therefore, we allowed the use of an assistive device and/or physical

assistance from the examiner or another individual during the 6-minute walking test. Because subjects with Alzheimer's disease often have difficulty understanding verbal commands and are easily distracted, we also allowed the examiner to provide both physical and verbal cues to continue walking during the testing period. The examiner was instructed to allow the patient to ambulate at his or her own pace. Many institutionalized individuals have very low endurance and were unable to ambulate the full 6 minutes. We allowed subjects to rest as often and as long as needed during the 6-minute test period. We recorded the time spent resting. We measured time elapsed during ambulation and rest periods using multiple stop watches. A calibrated surveyor's measure wheel (15) was used to measure the distance ambulated during the 6-minute period. To facilitate subject cooperation and reduce fatigue, the "Six-Minute Walking Test" was conducted as a continuation of the timed "Stand and Walk."

Speed

Each subject's ambulation speed was calculated for the timed 25-foot walk and for the 6-minute walk. Speed during the 25-foot walk was calculated by dividing 25 feet by the seconds required to walk that distance. Speed during the 6-minute walk was calculated by dividing the distance walked during this period by the number of seconds during the 6-minute period that the subject actually walked.

Procedure

Thirty-three subjects were tested in the morning and afternoon of two days, one week apart. On the first day of testing, rater 1 conducted the physical performance tests on all subjects in the morning and recorded the results. Then rater 1 repeated the physical performance tests on all individuals during the afternoon and recorded the results without referring to the findings recorded during the morning testing. On the second day of testing, one week later, two raters simultaneously conducted the physical performance tests on the same group of subjects during the morning. Each rater recorded the findings without discussion with the other rater. The physical performance tests were repeated in the afternoon with both raters recording their findings separately and without referring to the morning results.

Analysis

Intraclass correlation coefficients (ICCs) were calculated to examine agreement between examiners and time periods. An ICC [2,1] was used to examine inter-rater reliability, and an ICC [3,1] was used to examine intra-rater reliability (18). Based on generalizability theory, an analysis of variance was performed to determine the components of variance for each of the 6 tests (19).

RESULTS

Subject characteristics

The subjects tested ranged in age from 79 to 92 with a mean age of 84.7 years. Sixty-five percent of the subjects were female. Their Mini-Mental State Exam scores (20) ranged from 0 to 24 (mean = 9.34, median = 9). All subjects had a clinical diagnosis of Alzheimer's disease. All were long-term residents of a nursing home, with length of stay ranging from 121 to 3,065 days (mean 822, *SD* 533) (Table 1).

Subjects demonstrated considerable variability in physical performance. On average they were able to walk 333.5 feet in 6 minutes, but the range was from 8 to 843 feet *(SD* 187). The average time to rise from a chair and walk 25 feet was 41.7 seconds (range 8–158.3, *SD* 33.2).

Timed "Stand and Walk"—ICCs for the timed "Stand and Walk" ranged from .58 to .96. Generally, agreement was better between two examiners timing the same performance (ICC = .71–.96) than it was for the same examiner measuring a subject at two times (ICC = .58–.70). When the components of the "Stand and Walk" test were examined separately, agreement for the sit-to-stand component was much lower (ICC = −.07–.85) than was agreement for the 25-foot walking component (ICC = .57–.97). It is interesting to note that while the highest levels of agreement for the 25-foot walking component were between the two examiners (ICC =.85–.97), agreement between the examiners for the sit-to-stand component of this test was extremely low (Table 2).

Six-Minute Walk—Agreement between examiners and across time periods was excellent for the distance ambulated in 6 minutes. ICCs ranged from .80 to .99. Consistent with the findings for the 25-foot walking test, the highest levels of agreement were between the two examiners (Table 2).

Speed—We calculated the speed of ambulation in feet per second using data from the 25-foot and the 6-minute walking tests. The ICCs for speed calculated from the 25-foot walk ranged from .57 to .97, while the ICCs for speed calculated from the 6-minute walk ranged from .76 to .99. In all cases, agreement between examiners and across times was as good or better when speed was calculated based on the 6-minute walk than it was when calculated from the 25-foot walk (Table 2).

Sources of variance—The source of variance in the physical performance measures differed widely. Differences between the subjects accounted for 77% of the variance in measurement of the "Six-Minute Walk" but only 7% of the variance in the sit-to-stand portion of the "Stand and Walk" test (Table 3). Measurement error accounted for only 11% of the variance in the "Six-Minute Walk" test. However, it accounted for 61% of the variance in the sit-to-stand portion of the "Stand and Walk" and 32% of the variance in the "Stand and Walk" test as a whole.

DISCUSSION

The results of this study suggest that the "Six-Minute Walk" is the preferred test of physical performance for nursing home residents with Alzheimer's disease. Although we allowed the use of assistive devices and physical assistance, both intra-rater and inter-rater reliability of this test were highly satisfactory using the relatively demanding intra-class correlation coefficient. The "Six-Minute Walk" also demonstrated considerable stability with relatively modest fluctuation from morning to afternoon and week to week, despite the prevalent belief that the performance of individuals with Alzheimer's disease is demonstrably better in the morning (11). Analysis of the components of variance revealed that far more of the variance in this measure was due to subject differences (77%) than to measurement error (11%).

The sit-to-stand component of the "Stand and Walk" test was clearly the most problematic measure for this physically and cognitively impaired population. Providing physical assistance to the subjects during testing did not appear to harm the measurement properties of the "Six-Minute Walk." However, it may have introduced substantial measurement error in the sit-to-stand component of the "Stand and Walk" test. Only 26% of the variance in this measure was attributed to subject differences, whereas 32% was attributed to measurement error. We observed that a great deal of judgment on the part of the rater was required when the subject hesitated, often multiple times, before rising or required physical assistance to achieve an erect position. In subjects who required a great deal of assistance to assume an erect position, the time required to move from sitting to standing probably measured the performance of the examiner rather than the performance of the subject. For those who lack the strength and/or

coordination necessary to rise without assistance, a rating of the amount of assistance needed may be more reliable and more meaningful than a measure of the time required to stand up.

Our results support the contention (11) that some physical performance measures can be used to test individuals in the later stages of Alzheimer's disease, given appropriate modification. Although subjects with Alzheimer's disease may have difficulty following commands and/or require physical assistance, this does not prohibit the reliable assessment of physical performance if measurements are made over longer (6-minute walk) rather than shorter periods (25-foot walk).

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Table 1

Subject Characteristics and Walking Performance

Characteristic	Mean	*SD*	Range
Age	84.7	3.94	79.0–92.0
Mini-Mental State Exam score	9.3	6.0	0.0–24.0
Length of stay	822.0	533.0	121.0–3065.0
“Up and Go” time (secs)	41.7	32.2	8.0–158.3
6-minute distance (feet)	333.5	187.0	8.0–843.0
Speed over 25 feet (feet per sec)	1.0	0.6	0.17–3.6
Speed over 6 minuits (feet per sec)	1.0	0.5	0.03–2.5

Table 2

Reliability of Physical Performance Measures

	6-Minute Walk	25-Foot Walk	Sit-to-Stand	Stand and Walk	Speed (6 min)	Speed (25 ft)
Intra-rater* Examiner 1 Week 1 (AM/PM)	.90	.64	.55	.70	.89	.77
Intra-rater* Examiner 1 Week 2 (AM/PM)	.80	.67	.85	.58	.79	.54
Intra-rater* Examiner 2 Week 2 (AM/PM)	.84	.57	.33	.58	.84	.45
Intra-rater AM* Examiner 1 Week 1 to Week 2	.84	.73	.08	.68	.84	.53
Intra-rater PM* Examiner 1 Week 1 to Week 2	76	.72	−.04	.69	.75	.50
Inter-rater† AM	.99	.85	.00	.71	.98	.94
inter-rater† PM	.97	.97	−.07	.96	.96	.83

*ICC Model [2.1].

†ICC Model [3.1].

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Table 3

Sources of Variance (Percentages)

Source	Sit-to-Stand	25-Foot Walk	Stand and Walk	6-Minute Walk
Subject difference	7%	25%	26%	77%
Subject fluctuations due to time of day	0	31	25	2
Subject fluctuations week to week	25	20	17	9
Error due to time of day	1	0	0	1
Error week to week	25	0	0	0
Measurement error	61	23	32	11