Development of a Screening Tool for Safe Wheelchair Seating

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Abstract

Objectives: Most elderly nursing home residents who need wheelchairs are not being assessed individually to ensure proper prescription for safe and effective mobility. This study evaluated the use of a new screening tool, the Resident Ergonomic Assessment Profile for Seating (REAPS). **Methods:** This descriptive study design examined the reliability and validity of the REAPS in a Veterans nursing home. Fifty subjects (mean age = 78) were screened by four raters and an independent criterion expert. Test-retest reliability was performed on 18 subjects. Other measures included resident discomfort, mobility, and posture. **Results:** Although interrater agreement varied according to the items on the REAPS, ratings suggested reasonable agreement among various raters and the seating expert, and moderate overall sensitivity. REAPS scores provided by the raters were positively correlated with expert opinion, as well as performance measures of mobility and head angle. **Conclusions:** The REAPS is intended to serve as a brief, easily administered screen to identify individuals in need of formal wheelchair seating evaluation. The results of this study suggest that, pending minor revisions, nursing home staff members with minimal instruction can use this tool to conduct this type of screening. Future development and research is warranted to explore the efficacy of the REAPS across long-term care settings in both VA and community facilities. Utilization of a revised version of the REAPS to identify wheelchair seating problems could have important policy and funding implications for the future.

Introduction

According to the 2000 Census, an estimated 2.2 million Americans rely on wheelchairs to compensate for mobility impairments, and more than half are adults ages 65 and over. Older adults have a 43 percent probability of spending some time in a nursing home. Of those who do enter nursing homes, 55 percent can expect to spend a total of at least one year there, and 21 percent can expect to spend a total of at least five years.[1] Currently approximately 1.5 million older adults reside in nursing homes, and that the number is expected to double to 3 million by the year 2030.[2] Since more than 70 percent of elderly nursing home residents currently use a wheelchair,[3] the number of older adults with mobility issues living in nursing homes will increase concomitantly.

Several studies report that between 40 and 80 percent of nursing home residents who use wheelchairs for mobility need some type of seating intervention.[4–7] Research indicates that when wheelchairs and seating systems do not fit the individual needs of nursing homes residents, many problems can become evident: pressure ulcers, difficulty in propulsion, discomfort, dysphagia, falls, and decreased quality of life.[5, 8–12]

It is noteworthy that there currently is no documented measure of wheelchair assessment for residents in nursing homes. For example, even the minimum data set (MDS) with its 284 items designed to assess the medical, psychological, and social characteristics of nursing home residents, does not address any aspects of a resident’s size, shape, and functional abilities with regard to wheeled mobility. As a result, this otherwise comprehensive instrument may be biased (e.g., assuming the resident cannot propel a wheelchair independently) in some areas by the perception and interpretation of the nurse-reviewer, examiner, or person completing the tool. In many instances, wheelchair use might affect or influence some or all of the MDS categories. Assessment of the resident’s anthropometric characteristics and seated postural status then could provide important information that might otherwise be overlooked or misinterpreted. In response to this need, the present study focused on the development, evaluation, and utility of a brief screening assessment for identifying the need for adaptive seating in nursing home residents. The instrument, the Resident Ergonomic Assessment Profile for Seating (REAPS), was designed for use by individuals with little or no experience in measurement of wheelchair seating needs.

Method

Subjects

A convenience sample of 46 male and 4 female veterans ages 60 years and older (average age = 78 years: range = 60–96 years) was recruited over a 6-week period from the James A. Haley VA Nursing Home Unit in Tampa, Florida. Inclusion criteria were cognitively intact or mild cognitive impairment (based on MDS scores), use of a wheelchair for at least 6 hours per day, and ability to provide informed consent. Primary medical diagnoses included stroke (n = 24), cardiovascular disease (n = 6), diabetes (n = 5), and arthritis (n = 3). One participant had a below-the-knee amputation. Eleven subjects had sustained a fall within the previous 180 days. The sample size of 50 subjects was determined according to the recommendations of Donner and Eliasziw to ensure reliability of at least 0.80.[13]

Measures

For ease of administration by care providers with little or no adaptive seating expertise, the following measures were used.

Resident Ergonomic Assessment Profile for Seating (REAPS). The REAPS, as shown in the Appendix,[*] consists of two sections. Section I allows

[*] The Appendix is available from the corresponding author.

recording of data from the MDS, including diagnosis, cognitive status, communication ability, sensation level, skin integrity (presence/absence of pressure ulcers), swallowing problems, and ability to transfer and ambulate. Section II (description of current wheelchair) includes eight observer-rated items addressing current wheelchair posture and functioning. These eight major domains address (1) foot support, (2) knee support, (3) arm support, (4) head control, (5) visual field, (6) leaning forward, (7) leaning to the side, and (8) sliding downward. The questions that define the major postural observations (e.g., "Feet properly supported?" "Knees level with hips?") are numbered 1 through 8 and rated in yes/no response format. Total REAPS score is calculated by summing these eight items. Several items contain additional questions intended to provide staff with further description and clarification of problems (e.g., "Too high?" "Too low"?), and these questions are labeled A and B. The last three questions on the REAPS were reverse coded, such that the higher total scores suggest problems due to current seating and a need for a formal wheelchair seating evaluation. Thus, the REAPS scores could range from 8, suggesting no problems, to 16, suggesting problems in all eight domains.

Expert opinion. An independent seating expert (a licensed kinesiotherapist with 25 years of seating experience, hereafter referred to as the SE) evaluated each subject using only his expertise and without knowledge of the REAPS. The SE recorded the type of wheelchair currently used (standard or custom fitted) as well as a recommendation of one of four options: no change in wheelchair needed; adjust the current wheelchair; modify the current wheelchair; or replace the current wheelchair.

Mobility. Each subject was asked to propel a distance of 10 feet while being timed with a stopwatch. Measurement was the average of three trials, with a maximum of 30 seconds allowed. Any subjects unable to propel were recorded at 31 seconds.

Posture. This was the ability of a resident to sit upright in a wheelchair for 30 seconds, when asked to do so, without leaning to the left or right, and was measured using a goniometer placed upright at the top center of the back of the wheelchair. The angle of deviation of the head, using the mid-sagittal plane as a reference from the premeasured midline (i.e., lean to the left or right) was noted and recorded. Thus, head angle was measured as a continuous variable.

Discomfort. Residents were asked to rate their discomfort using a numeric rating scale (NRS) ranging from 0 (no discomfort) to 10 (extreme discomfort) to measure intensity, and to point to the location of any discomfort using an outline picture of the body.

Procedure

For each of the 50 subjects, informed consent was collected, the REAPS was administered, an expert provided a rating, discomfort was measured, posture was measured, mobility was timed, and a repeat discomfort measure was taken.

Expert rating. The seating expert was asked to categorize subjects' wheelchairs as either standard or custom. A standard wheelchair was defined as a chair with a seat 18 inches wide and 16 inches deep, a seat height from the floor of 20–21 inches, a "sling" seat and back, and nonadjustable armrests. A custom wheelchair was defined as a nonstandard wheelchair frame (e.g., narrow width or lower seat) or one with dimensions that had been custom fitted to match the person, or a chair equipped with custom components manufactured or installed specifically for a resident.

Interrater reliability. Residents were rated by three staff members—a nursing assistant (NA), a licensed practical nurse (LPN), and a kinesiotherapist (KT)—and the investigator (PI), all using the REAPS. For each subject, all four raters administered the REAPS simultaneously and independently of one another before moving on to the next subject.

Test-retest reliability. The investigators also were interested in determining whether a single period of observation would be representative of a resident's typical posture and discomfort, or if it would constitute an isolated event. To make this determination, the researcher and the KT were able to recruit 18 of the 50 subjects for a follow-up one week later. At that time they readministered both the REAPS and the discomfort scale.

Results

Of the 50 subjects, 26 were in standard wheelchairs and 24 were in custom wheelchairs. The seating expert categorized 15 subjects (30 percent) as needing no change in their wheelchairs, 4 (8 percent) as needing adjustment, 14 (28 percent) as needing modification, and 17 (34 percent) as needing replacement of their wheelchairs. Subjects who were recommended for change in their wheelchairs were twice as likely to be in standard chairs than custom ones. Frequencies of problems observed by the raters within each of the eight domains are shown in Table 1.

Exact agreement percentage levels and Cohen's kappa statistic for interrater reliability were calculated for each pair of raters on each of the eight major domains. The exact agreement level used in subsequent analyses throughout the study was based on the standards described by Nunnally and Bernstein,[14] who suggest that using instruments that have only modest reliability (e.g., 0.70) in the early stages of predictive or validation research is a practical approach. Average agreement for each of the eight domains was determined by summing the percent agreement of the pairs of raters and dividing by the number of raters. The average of all four raters ranged from 72 percent to 98 percent, and the average agreement among the three staff members (i.e., excluding the principle investigator/author) was similar, ranging from 70 percent to 98 percent.

Kappa values were extremely varied, ranging from -0.174 to 0.430. However, the low prevalence or absence of certain problems/symptoms makes Cohen's kappa in this study difficult to interpret. In general, Cohen's kappa is

Table 1. Number of subjects identified by raters as having a seating problem within each domain

Item rated	Nursing assistant	Licensed practical nurse	Kinesio-therapist	Principal investigator
1. Feet improperly supported	9	6	25	17
2. Knees not level with hips	6	0	15	16
3. Elbows not resting at correct height	11	5	12	20
4. Head requires support	0	2	1	1
5. Eyes not facing forward	5	6	5	7
6. Resident leans forward	2	21	2	9
7. Resident leans to side	12	11	10	22
8. Resident slides down/out of chair	3	6	10	10

recommended as a measure for assessing interrater reliability for nominal level data among pairs of raters. However, it has two disadvantages that impact the present study. First, when one member of the pair does not observe the presence of a symptom, kappa cannot be calculated. This occurred for three of the items for one or more pair of raters indicating no problem with knees being level with hips, holding head up without support, and leaning forward. Second, when a condition/symptom is of low prevalence, the kappa may be calculated as a negative value.[15, 16] This occurred for two items (hold head up without support and eyes facing straight forward) involving the KT and LPN and once with the PI (author) and the LPN.

As previously mentioned, the KT and the PI readministered the REAPS to 18 subjects one week later in an attempt to establish test-retest reliability of the instrument. Exact agreement percentage levels and Cohen's kappas for test-retest reliability of the REAPS were calculated and are displayed in the table below.

Table 2 describes the test-retest reliability of the REAPS in exact percentage agreement level and Cohen's kappa for Time 1 (the first measurement involving all 50 subjects) and Time 2 (the second measurement a week later, involving 18 subjects) of the KT and the PI, as well as between the two raters. Overall, the average percentage level of agreement between Time 1 and Time 2 for both the KT and the PI exceeded the expected 70-percent level (81 percent and 74 percent, respectively), although certain test-retest responses on REAPS questions fell below 70 percent. Results suggest that ratings on items 1 and 2, "Are feet properly supported?" and "Are knees level with hips?", respectively, fell below the expected criteria for both the KT and the PI when comparing Time 1 and Time 2. This should be interpreted with caution, since 4 of the 18 retest subjects were in different wheelchairs at Time 2. For example, one subject's wheelchair had been stolen, and he was placed temporarily in a type of wheeled easy chair that offered poor postural support. His score changed from 8 at Time 1 to 11 at Time 2, as rated by both the KT and the PI. Another subject's wheelchair was changed from a standard width to a narrow width between Time 1 and Time 2, and his score changed from 12 to 9, as rated by the KT, and from 13 to 8, as rated by the PI.

Table 2. Test-retest reliability for kinesiotherapist (KT) and investigator (PI)

	T1/T2 KT	T1/T2 KT	T1/T2 PI	T1/T2 PI	T2 agreement between KT and PI	T2 agreement between KT and PI
REAPS Items	**%**	**Kappa**	**%**	**Kappa**	**%**	**Kappa**
1	61	.241	56	-.108	89	.753
2	56	.000	56	.014	94	.880
3	78	.446	72	.430	72	.416
4	100	1.00	100	1.00	100	1.00
5	100	1.00	78	-.125	94	.640
6	100	1.00	67	-.174	94	.640
7	83	.471	78	.556	89	.684
8	67	.053	83	.557	100	1.00
Total score	81% average		74% average		91.5% average	

T1 = the first measurement (Time 1), involving all 50 subjects
T2 = the second measurement (Time 2), involving 18 subjects who were reevaluated

There was a high level (91.5 percent) of exact agreement between raters at Time 1 and Time 2, indicating that both raters reported similar observations regardless of a change of wheelchairs in the four subjects. Separate analyses of variance (ANOVAs) were performed to compare the expert's recommendations with the individual raters' REAPS scores. Results are displayed in Table 3.

Table 3. Comparison of seating expert with raters' REAPS scores

		Total REAPS scores							
		NA		LPN		KT		PI	
Expert rating		**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Overall	No change n = 15	8.13	.35	8.80	.86	8.73	1.03	8.60	.51
	Change n = 35	9.11	1.02	9.09	1.09	9.80	1.28	10.34	1.47
	Significance	*P* = 0.001		ns		*P* = 0.006		*P* = 0.000	

NA = nursing assistant
LPN = licensed practical nurse
KT = kinesiotherapist
PI = principal investigator
M = mean rating of value range from 8 to 16
SD = standard deviation
ns = not significant

The average REAPS scores of the four raters—the nursing assistant, the licensed practical nurse, the kinesiotherapist, and the investigator—were compared with the recommendations of the expert as broken down into two groups: no change and change (including adjust, modify, and replace wheelchair). Results were found to be significant, $F(1, 48) = 14.99$, $P < 0.000$.

Sensitivity and specificity were also calculated by comparing expert opinion (categorized as change versus no change) with raters' total scores (categorized as 8 versus 9 or higher). These results are displayed in Table 4.

Table 4. Sensitivity and specificity

	Sensitivity	Specificity
NA	.92	.80
LPN	.60	.47
KT	.83	.57
PI	.83	.40

NA = nursing assistant
LPN = licensed practical nurse
KT = kinesiotherapist
PI = principal investigator

As indicated above, the REAPS was designed to be sensitive, but not specific. Since one scale point on the REAPS was established as a cut point to warrant further intervention, the authors acknowledge that some false positives occurred as a result.

As demonstrated in Table 5a, with the exception of the KT ratings, REAPS scores were positively correlated with mobility as measured by time for propelling. As demonstrated in Table 5b, with the exception of the KT ratings, total REAPS scores also were positively correlated with head angle.

Table 5. Correlations (Pearson r) of total REAPS scores with mobility and head angle

Table 5a. Correlation of total REAPS scores and mobility

	NA	LPN	KT	PI	Avg. 3 raters	Avg. 4 raters
r	.335	.146	.301	.421	.358	.405
Significance	.017	ns	.034	.002	.011	.004

Table 5b. Correlation of total REAPS scores and head angle (as measured in degrees of lean)

	NA	LPN	KT	PI
r	.361	.306	.204	.363
Significance	.010	.031	ns	.010

NA = nursing assistant
LPN = licensed practical nurse
KT = kinesiotherapist
PI = principal investigator

Discussion

The Resident Ergonomic Assessment Profile for Seating was designed to serve as a preliminary screen to allow any nursing home staff member to identify residents who would benefit from the need for adaptive seating or a custom-fitted wheelchair. Exact agreement levels among raters varied, with four questions containing paired responses that fell below the expected 70 percent value. Question #1, “Are feet properly supported?” had the least agreement and may be explained by the fact that several subjects presented with no footrests on their wheelchairs (since they propelled with their feet). The raters were unsure how to respond when the resident’s feet were on the floor rather than on footrests. In future revisions of the REAPS, this question should be further refined to add the lack of footrests as a response option. Question # 6, “Does resident lean forward?” indicated low agreement levels between the LPN and all other raters. It will need further revision and explanation prior to the administration of the REAPS so that the rater will understand “leaning forward” as describing a postural (versus a behavioral) trait. Question # 3, “Do elbows rest at natural height on armrests?”, and question #7, “Does resident lean to side?”, were potentially influenced by investigator bias as the PI was more likely to detect subtle deficits in the subjects’ arm position and slight leaning to the side.

The KT and the PI retested 18 subjects one week after the initial REAPS administration in an attempt to establish test-retest reliability. There was a high level (91.5 percent) of exact agreement between raters at Time 1 and Time 2, which may indicate that both raters reported similar observations regardless of a change of wheelchairs in four of the 18 subjects.

The four raters’ total REAPS scores for the 50 subjects ranged from 8, indicating no problems, to 13, indicating many problems. The seating expert in this study indicated that 30 percent of the sample did not require any change to their wheelchairs and that 70 percent required some change in the form of adjustment, modification, or replacement of their existing wheelchair. A cut-point of 9 was determined to indicate a need for a formal seating evaluation by a trained therapist. The justification for this cut-point is simply that each REAPS item is intended to examine seated posture, and identification of a problem in any one of the categories merits further intervention. Sensitivity was moderate overall, and raters identified most of the cases that the expert judged as needing change.

As a potential screening tool, the REAPS should serve the purpose of generating a referral for formal seating evaluation when any postural problems are identified. Participants who were either unable to propel or who propelled very slowly tended to have significantly higher total REAPS scores, while those subjects with better mobility had lower REAPS scores. This is not surprising, as certain postural problems (e.g., not being able to reach the floor when foot propelling is necessary, or not being able to reach the wheels if hand propelling is necessary) can preclude the ability to propel. There was a significant positive correlation between total REAPS scores and head angle measurement in degrees of lean.

The REAPS offers a “snapshot” of residents’ seated wheelchair posture at a given point in time, so it is therefore recommended that the screen be administered at least twice, a minimum of 3 days apart. This will reduce the occurrence of misinterpreting an isolated “bad day” as a chronic seating issue. It may also enhance performance of the screen if administered by a caregiver who is familiar with the resident and who, therefore, may be able to detect patterns of poor posture as opposed to episodic instances.

The limited opportunity for variance on the items due to the yes-no format of the REAPS, as well as the low number of items, influenced internal reliability. The parsimonious approach to the number of REAPS items was an attempt to capture common postural problems with just a few easy-to-understand observations.

Certain traits measured by the REAPS appear to be more stable than others over time and may need to be weighted differently from other questions and observations. For instance, the ability to hold one's head up without support is less likely to change than foot support, which can vary a great deal if footrests are left off or are adjusted improperly (e.g., too high or too low). The very low prevalence of certain problems in this study (e.g., inability to hold head up without support and its subsequent high level of agreement) might suggest statistically that the item be dropped from the screening tool. However, the REAPS is a clinical tool designed for use in long-term care facilities and must be suitable for use in various seating environments where there is potential for greater resident impairment.

REAPS scoring was found to be simple and efficient. Although utilizing a cut-point of 9 in REAPS scoring resulted in some false positives (i.e., some wheelchairs may need only minor adjustment that could be performed by a nonclinical person), consulting a therapist would preserve the safety and health interests of the resident. There was minimal instruction (less than 10 minutes) provided to the raters by the investigator in order to determine a baseline without formal training. This was deliberate, in an effort to find any weak areas in the screen or any questions that might cause confusion. Future studies involving the REAPS will include standardized training sessions as well as the following revisions:

1. Illustrations next to each REAPS question in an effort to help clarify observations (e.g., "too high" or "too low").
2. Multiple administrations of the REAPS conducted several (ideally five) times per week, at the same time of day by the same rater(s).
3. Discomfort measurement standardized by the number of hours each participant will have been in the wheelchair at time of assessment.
4. Only wheelchair-induced discomfort measured for future studies.

It is important to note that this study was conducted in a Veterans Affairs (VA) nursing home, as opposed to a community nursing home. There are several potentially important differences in these two categories of nursing homes. First, the James A. Haley nursing home generally does provide individualized wheelchair seating for its residents, whereas most community nursing homes do not. This could possibly affect the wheelchair seating status of residents. Because it is more likely that the VA population would be in customized wheelchairs, it may be more difficult to achieve a representative sampling across settings in a study without including both VA and non-VA sites. Second, funding is available for individualized seating in the VA nursing home, whereas Medicare and Medicaid do not fund individualized wheelchairs in community nursing homes. Finally, the VA nursing home population is predominately male, while the community nursing home population is predominately female. Although this may not affect study outcomes, it has the potential to introduce bias to a study of this nature. For example, REAPS scores could well be affected by the anthropometric differences (on average, men tend to be taller and larger than women) and prevalence of certain spinal deformities, particularly kyphosis, that are gender-related (i.e., more prevalent in women). For these reasons it is likely that the REAPS scores would be affected by the setting, but the clinical utility would not be diminished.

There are potential policy implications when using the REAPS in a community nursing home. For example, if wheelchair-seating problems are identified and documented, the nursing home would be obligated to offer some type of resolution. While this may place the initial burden of cost on the facility, it is possible that a seating intervention program could result in overall cost reductions (e.g., staff time saved if residents could self-propel, elimination of repositioning needs, injury prevention during transfers).

Conclusion

With further development and testing, the REAPS may offer potential as a screening tool for use in nursing homes to provide quick and appropriate referrals to therapy departments to address postural problems before they cause or exacerbate medical problems and jeopardize the health and quality of life of residents. Additional studies conducted in other long-term care settings would provide valuable information for future use. For example, a larger study with randomly selected subjects (potentially more impaired) from multiple nursing homes (VA and non-VA) could be conducted using a repeated measures design with daily observation by multiple raters over a 1-week period. Results could be used not only to identify seating problems within each facility, but also to estimate the prevalence of the need for seating intervention across the long-term care population. This could have important policy and funding implications for the future.

Acknowledgments

This material is based upon work supported by the Office of Research and Development, Rehabilitation Research and Development, Department of Veterans Affairs, at the James A. Haley VA Hospital in Tampa, Florida.

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