Medication Management Capacity in Highly Functioning Community-Living Older Adults: Detection of Early Deficits

Helen K. Edelberg, MD, Elizabeth Shallenberger, RN, MBA, and Jeanne Y. Wei, MD, PhD

OBJECTIVE: The Drug Regimen Unassisted Grading Scale (DRUGS) was developed and employed in testing the hypothesis that the inability to take medication independently may correlate with the presence of cognitive impairment.

DESIGN: Cross-sectional study.

SETTING: Two continuing care retirement facilities in the Greater Boston area.

PARTICIPANTS: The study population included outpatients ≥ 70 years old.

MEASUREMENTS: We developed a novel performance-based measure, the DRUGS tool, involving a step-wise progression of four tasks: (1) identification; (2) access; (3) dosage; and (4) timing.

RESULTS: Fifty-nine participants aged 84.2 ± 5.1 years (mean ± SD) completed the study. The DRUGS tool score was inversely related to age ($r = -.41$, $P = .001$). Compared with independent-living, residence in assisted-living was associated with lower DRUGS tool scores (82.0% vs 93.8%, $P = .009$). The DRUGS tool score was associated with self-reported Medication Management capacity (94.8% able vs 86.2% unable to take medications independently by self-report, $P = .047$). Both DRUGS tool score and self-reported Medication Management capacity were associated with MMSE ($P = .0008$ and $P = .044$, respectively). The multivariate model, with DRUGS tool Summary Score as the dependent variable, adjusted for age and sex, included MMSE ($P = .023$) and self-reported IADL ($P = .038$).

CONCLUSION: There is an association between performance on the DRUGS tool and level of cognitive function. The DRUGS tool represents a unique individualized, yet standardized, assessment of the ability to function independently for ambulatory older persons. It may be useful for identifying those highly functioning older persons, at an early phase of cognitive decline, in whom targeted intervention would likely be most effective and efficient. **J Am Geriatr Soc 47:592–596, 1999.**

Key words: drugs; functional assessment; cognitive impairment

This research was supported, in part, by HHS grants AG00294, AG08812, and AG00251.

The manuscript was presented, in part, at the annual meeting of the American Geriatrics Society, Atlanta, Georgia, May 1997.

Address correspondence to Dr. Jeanne Wei, Gerontology Division, RA-440, Beth Israel Deaconess Medical Center, 330 Brookline Avenue, Boston, MA. 02215.

From the Gerontology Division, Beth Israel Deaconess Medical Center, Division on Aging, Harvard Medical School, Boston, Massachusetts.

To date, widespread ambulatory screening of older persons to detect and predict the onset of functional decline remains an elusive goal. A number of subjective multidimensional measures of level of function based on self-report (or caregiver report) are currently available to primary care physicians.[1–5] Other screening tools that rely on direct observation may complement these self-report measures and, across a broad spectrum of the functional status, may be useful in predicting functional decline.[6] To this end, a number of performance-based tests have been developed and validated for geriatric assessment.[7–11] However, because their focus has been primarily on physical function, these tools often provide less insight into the psychological, medical, or social factors that contribute importantly to the overall functional status of older persons.

Population-based screening data suggest that needing or receiving assistance with medication management may predict increased risk of frailty.[12] Medication management not only requires a defined set of mental and physical skills but higher level cortical processing and integration.[13,14] Optimal medication use is one key to successful aging.[15] On average, community-dwelling older persons take three prescription medications per day.[16,17] The vast majority of older persons are responsible for taking their own medications. However, as many as 40% fail to take their prescribed medication properly.[18,19] Previous studies of medication management, employing questionnaires, hypothetical scenarios, or separate specific tasks, were not designed to explore the relationship between medication management, functional status, and the risk of functional decline.[13,14,20–22]

We recently developed a Geriatric Screening Tool to assess medication management and various aspects of function in the ambulatory setting. The proposed utility of this tool is based on the theory that mental and physical functions are interdependent. Both cognitive impairment and physical disability are associated with functional decline.[23,24] Cognitive impairment has been associated with the inability to take medications independently as well as with gait disorders, falls, and functional impairment.[14,20–23,25,26] The onset of functional impairment and disability may be heralded by subtle changes in either cognitive or physical status.

METHODS

We sought to test the hypothesis that it is possible to develop an objective geriatric screening tool to assess different aspects of higher level function in the ambulatory setting. The Drug Regimen Unassisted Grading Scale (DRUGS) tool, described below, is an extension of one item of the Instru-

0002-8614/99/$3.50

mental Activities of Daily Living (IADL) scale, a well validated test of functional status, and the "brown bag" test, a technique commonly used for medication review whereby the patient brings a bag full of his/her drugs to the physician's office.[27] Unlike the other tests of medication management, however, the DRUGS tool is a performance-based, individualized measure that examines the patient's capacity to manage his/her own medication regimen.

Tool Development

We developed the DRUGS tool as a step-wise progression of four tasks: (1) *identification:* showing the appropriate medications, (2) *access:* opening the appropriate containers, (3) *dosage:* dispensing the correct number per dose, and (4) *timing:* demonstrating the appropriate timing of doses. The participant is asked to perform the four tasks for each of the prescription and nonprescription medications that he/she plans to take on the day of the evaluation, including PRN (as needed) medications, using the DRUGS tool. A visual aid, a sheet of paper marked with an empty grid titled "time" (7 a.m.-11 p.m.), "meal" (breakfast, lunch, dinner), and "medications" is employed in order to standardize the process. The reference medication list is obtained from the outpatient medical record or, if this is unavailable, the labels of the up-to-date medication containers. Dose changes that are not documented in the chart, but which are reported by the patient or suggested by inconsistencies in labeling, are verified with the primary care physician.

Total Score Assigned

Regarding PRN medications, the participant is *able* to perform the task if (1) the dose and timing match either the medication list in the chart or the container or (2) the dose and timing are reasonable based on the prescribing information in the *Physician's Desk Reference* and there is no absolute contraindication to taking the medication.[28]

The investigator adds up the number of medications on the reference medication list and multiplies by four to obtain the Maximum Score. With *able* = 1 and *unable* = 0 for each task for each medication, the investigator adds up the numbers in each column, divides by the Maximum Score, and multiplies by 100 to create a Summary Score (0–100%). The four tasks are completed for each medication and weighted equally. The participant is assigned zero out of four for not showing a regular medication. The tester may assist the participant who is *unable* to open a container so that he/she may proceed to the next task.

Patients And Setting

This cross-sectional study was conducted at two continuing care retirement facilities in the Greater Boston area. Patients were recruited from the Beth Israel Deaconess Gerontology Group practice between October 10, 1996, and January 27, 1997. All ambulatory community-dwelling patients aged 70 years and older who presented to one of the study sites were eligible for the study. Patients were excluded if they were currently not taking any prescription or nonprescription medications or if they refused to participate.

Data Collection

Data for all participants were collected at the time of the outpatient office visit (HE, ES). The initial contact was used to obtain written informed consent and collect clinical data. The chart review data included the list of medications and the 19 variables that constitute the Charlson Comorbidity Index.[29] The Institutional Review Board of the Beth Israel Deaconess Medical Center approved the protocol.

Geriatric Screening Tools

Self-Report

Modified Katz Activities of Daily Living (maximum score = 6) and Lawton IADL (maximum score = 8) scales were used to assess basic and instrumental activities of daily living, respectively.[27,30] In addition, each participant was asked the Medication Management questions: (1) "Do you take your own medication without help?" (2) "Does someone remind you to take your medication on a regular basis?" and (3) "Does someone set up your medication in advance?" If the participant answered "no" to question (1) or "yes" to either (2) or (3), they were assigned a Medication Management score of 1. Whenever possible, the caregiver was asked the same set of questions.

DRUGS Tool

An investigator who was blinded to health status (HE, ES) ascertained DRUGS tool status. The performance was timed using a stopwatch, without adjustment for number of medications or doses, to determine feasibility of use in clinical practice.

Standard Measures of Functional Status

The results of these Geriatric Screening Tools were compared with a complement of previously validated Standard Measures of Functional Status, which were categorized for clinical relevance. There were tests of cognitive status (Mini-Mental State Exam); affective status (Geriatric Depression Scale); physical function (timed "Up and Go" test); medical conditions (Jaeger card to test near vision, Charlson Comorbidity Index); medication-specific factors (number of medications, number of doses); and social factors (living arrangement).[31–34] These tests, which are used routinely in comprehensive geriatric assessment, were specifically chosen because they could be administered in 30 minutes or less. Covariates included age, gender, and level of education.

Data Analysis

Univariate and multivariate analyses were performed using the SAS statistical package for Windows, version 6.12 (Carey, NC). Univariate associations between the continuous outcome (DRUGS Summary Score) and continuous variables were examined by Spearman correlation. Student's *t* test was used to compare the DRUGS score between two groups for binary predictors. Spearman correlation, chi-square, and Wilcoxon rank sum tests were employed to examine the relationships between predictors. Comparisons between the participants who achieved scores above and below a series of predetermined thresholds were then analyzed with the Wilcoxon rank sum test or Student's *t* test for continuous data and the chi-square or Fisher's exact test for categorical data.

A multivariate model in which the dependant variable was the DRUGS tool Summary Score was derived using stepwise linear regression. Age, sex, and covariates with $P < .2$ on univariate analysis were entered into the model. Age, sex, and variables with $P < .05$ were allowed to remain in the model. Collinearity diagnostics were performed on the final

model. Nonsignificant predictors were entered into the final model to check for uncontrolled confounding (change in β-coefficient of > 10%). Residual and regression diagnostics were performed.

RESULTS

We approached a total of 67 subjects. Two did not take any medications, and five declined to participate (these individuals were more cognitively and functionally impaired than those who agreed to participate). A total of 60 subjects were enrolled in the study. Fifty-nine patients completed the study; one patient was excluded from the analysis because she failed to bring her medications to the clinic. The mean ± SD age was 84.2 ± 5.1 years (range 72 to 93), and 72% of participants were women. Forty-four participants (73%) lived alone. Forty-one of the 59 participants (68%) had received a college degree. Two wheelchair-bound patients were unable to perform the timed "Up and Go" test.

Univariate Analysis

The mean DRUGS tool Summary Score was 93.2 ± 11.25 (range 50 to 100). Interrater reliability and test-retest reliability were >.90. The DRUGS tool score was inversely related to age ($r = -.41$, $P = .001$). There was no statistically significant association between DRUGS score and gender, level of education, or living arrangement. Residence in assisted-living (n = 3) was associated with lower DRUGS tool scores compared with independent living (82.0% vs 93.8%, $P = .009$).

Table 1 demonstrates the relationship between the Standard Measures of Functional Status, self-report Geriatric Screening Tools, and DRUGS tool outcome. The DRUGS tool score was associated with self-reported Medication Management capacity (94.8% able vs 86.2% unable to take medications independently, by self-report; $P = .047$). Both the DRUGS tool score and self-reported Medication Management capacity were associated with MMSE ($P < .001$ and $P = .044$, respectively) and time to complete the test ($P = .026$ and $P = .025$, respectively). In addition, self-reported Medication Management capacity was associated with timed "Up and Go" (12.2 vs 15.6, $P = .006$) and self-reported IADL capacity (6.9 vs 4.4, $P = .001$). Self-reported ADL and IADL scores were not related significantly to DRUGS tool outcome.

Given the high average DRUGS tool score, we sought to determine whether analysis by discrete intervals could be meaningful for this particular group. When the threshold was set at 80%, there was a statistically significant association between the Jaeger scores, timed "Up and Go" scores, GDS, MMSE, and the DRUGS tool ($P = .018$, $P = .036$, $P = .012$, $P = .016$, respectively). At the 85% threshold, both GDS and MMSE were associated significantly with the DRUGS tool ($P = .047$, $P = .001$, respectively). At thresholds of 90% and 95%, there was a persistent association between MMSE and DRUGS tool ($P = .002$, $P = .001$, respectively) (Figure 1).

Correlation analysis between the individual tasks and the Standard Measures revealed a statistically significant association between the tasks of access, dosage, timing, and the MMSE ($r = .24$, $P = .044$; $r = .32$, $P = .015$; $r = .33$, $P = .010$, respectively). The other individual tasks and the Standard Measures of Functional Status were not otherwise significantly associated. There was no significant association between DRUGS tool score and the number of drugs or the number of doses. The mean time ± SD to complete the evaluation was 256.7 ± 171.4 seconds. This was not related significantly to DRUGS tool outcome. Time to completion was, however, correlated with the number of medications ($r = .69$, $P = .001$) and number of doses ($r = .62$, $P = .001$).

Multivariate Analysis

The final model, with DRUGS tool Summary Score as the dependent variable, adjusted for age and sex, included MMSE ($\beta = 1.33$, $P = .023$) and self-reported IADL ($\beta = 1.47$, $P = .038$), the total number of medications ($\beta = 1.66$, $P = .081$), and the total number of doses ($\beta = -.90$, $P = .099$). There was no evidence of collinearity between the variables in the model by Belsey-Kuh-Welch criteria. Outliers (data points with Jacknife residuals >3 or <−3) were removed, and the model was rerun without significant change in the β-coefficients. There were no influential points (Cook's Distance > 1).

Table 1. Relationship Between Standard Measures, Self-Report, and DRUGS Tool

	Correlation (r)*	(P Value)
Standard		
Charlson Index	−0.41	(0.23)
Jaeger Score	−0.14	(0.27)
MMSE	0.42	(0.0008)
GDS	−0.23	(0.06)
TUAG, sec.	−0.17	(0.21)
Self-report		
ADL capacity	0.17	(0.19)
IADL capacity	0.22	(0.09)
MM capacity†	94.8% vs. 86.2%	(0.047)
DRUGS tool		
Total number	−0.24	(0.85)
Total doses	0.04	(0.77)
Time to completion	−0.29	(0.03)

* = Spearman correlation coefficient; MMSE = Mini-Mental State Exam; GDS = Geriatric Depression Scale; TUAG = timed "Up and Go"; MM = self-reported Medication Management; † = Wilcoxon rank sum test.

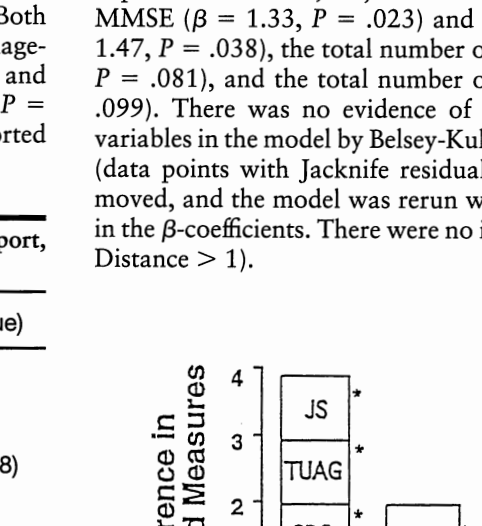

Figure 1. Difference in standard measures of functional status by DRUGS performance score. The standard measures are: MMSE = Mini-Mental State Exam; GDS = Geriatric Depression Scale; TUAG = timed "Up and Go" score; JS = Jaeger score. Level of statistical significance is denoted by *$P = < .05$ or † = $P < .01$.

DISCUSSION

This study has several major findings. First, there is an association between DRUGS tool outcome and cognitive status. Second, the ability to take medications independently appears to be unrelated to the number or dosage frequency of drugs. Third, this test represents a unique customized assessment of function in ambulatory older persons.

There is a statistically significant association between DRUGS tool outcome, self-reported Medication Management capacity, and cognitive status as measured by the MMSE. This finding is consistent with previous studies that have examined the relationship between cognitive and functional impairment and the capacity for independent medication management.[20,35,36] A MMSE score of 24 or less is a rough proxy for the cognitive aspects of medication management. These findings suggest that the DRUGS Summary Score may identify a subset of community-dwelling older persons with subtle, yet clinically significant, changes in his/her level of cognitive function.

Independent medication management, as measured by self-report as well as by the performance-based DRUGS tool, does not appear to be related to the number or dosage frequency of drugs. This confirms the importance of patient-specific physiologic and functional characteristics when predicting adverse outcomes associated with specific drug therapies.[37]

The DRUGS tool has both clinical and research applications. Although the proposed performance-based measure is standardized, the patient relies on his own medication list/containers. Inasmuch as the DRUGS tool performance reflects the patient's basic medication-taking skills as well as his ability to adapt to his own impairment(s), the practitioner is able to identify specific problems with the individual's therapeutic regimen immediately. Pharmacoreduction, patient education, use of compliance aids, and appropriate follow up by health care professionals may result in improved clinical outcomes.[38–42]

There are several limitations to this study that deserve comment. The chart prescription record may not be entirely accurate. Measurement bias cannot be completely excluded. The relatively small sample size provides potential for type II error. Also, it is not known whether the findings from this select group of healthy, well educated, highly functional older people would be generalizable to the at large population of older persons. The findings of this study suggest that there might be a ceiling effect; additional validation utilizing a more diverse population may result in a broader range of test scores.

In summary, the ability to take one's own medications independently, as measured by the DRUGS tool, an easy to administer, performance-based test, appears to be related to cognitive status. It appears to be unrelated to the number of medications and/or doses. The most common problems that are encountered in in-home assessment of medication usage are discrepancies between labeled dosage and dosage actually used, potential drug interactions, and underuse of medication.[17,43] In addressing these and other potential problems, the recently developed DRUGS tool may have intrinsic value for improving care of the individual patient. It may help to prompt the clinician to simplify a drug regimen, elicit specific recommendations from a pharmacist, or initiate the implementation of home services. The DRUGS tool appears to be a sensitive indicator of cognition and other measures of functional status. It represents a unique, individualized, yet standardized assessment of higher level function in ambulatory older persons.

REFERENCES

1. Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). Conceptual framework and item selection. Med Care 1992;30:473–483.
2. Nelson EC, Wasson JH, Johnson DJ, Hays RD. Dartmouth COOP functional health assessment charts: Brief measures for clinical practice. In: Spilker B, ed. Quality of Life and Pharmacoeconomics in Clinical Trials. Philadelphia: Lippincott-Raven, 1996.
3. Lachs MS, Feinstein AR, Cooney LM et al. A simple procedure for general screening for functional disability in elderly patients. Ann Intern Med 1990; 112:699–706.
4. Moore AA, Siu AL, Partridge JM et al. A randomized trial of office-based screening for common problems in older persons. Am J Med 1997;102:371–378.
5. Maly RC, Hirsch SH, Reuben DB. The performance of simple instruments in detecting geriatric conditions and selecting community-dwelling older people for geriatric assessment. Age Ageing 1997;26:223–31.
6. Reuben DB, Siu AL, Kimpau S. The predictive validity of self-report and performance-based measures of function and health. J Gerontol Med Sci 1992;47:M106–110.
7. Guralnik JM, Simonsick EM, Ferrucci L et al. A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol Med Sci 1994;49:M85–94.
8. Fillenbaum GG. Screening of the elderly: A brief instrumental activities of daily living measure. J Am Geriatr Soc 1985;33:698–706.
9. Gerety MB, Mulrow CD, Tuley MR et al. Development and validation of a physical performance instrument for the functionally impaired elderly: The Physical Disability Index (PDI). J Gerontol Med Sci 1993;48:33.
10. Jette AM, Davies AR, Cleary PD et al. The Functional Status Questionnaire: Reliability and validity when used in primary care. J Gen Intern Med 1986; 1:143–149.
11. Williams ME, Gaylord SA, Gerritty MS. The Timed Manual Performance test as a predictor of hospitalization and death in a community-based population. J Am Geriatr Soc 1994;42:21–27.
12. Brody KK, Johnson RE, Douglas LR. Evaluation of a self-report screening instrument to predict frailty outcomes in aging populations. Gerontologist 1997;37:182–191.
13. Hurd PD, Butkovich SL. Compliance problems and the older patient: Assessing functional limitations. Drug Intell Clin Pharm 1986;20:228–31.
14. Fitten LJ, Coleman L, Siembieda DW et al. Assessment of capacity to comply with medication regimens in older patients. J Am Geriatr Soc 1995;43: 361–367.
15. Monane M, Monane S, Semla T. Optimal medication use in elders. Key to successful aging. West J Med 1997;167:233–237.
16. Whittington FJ, Petersen DM, Dale B et al. Sex differences in prescription drug use of older adults. J Psychoactive Drugs 1981;13:175.
17. Ostrom JR, Hammarlund ER, Christensen DB et al. Medication usage in an elderly population. Med Care 1985;23:157–164.
18. Law R, Chalmers C. Medicines and elderly people: A general practice survey. BMJ 1976;1:565–568.
19. Morrow D, Lierer V, Shiekh J. Adherence and medication instructions. Review and recommendations. J Am Geriatr Soc 1988;36:1147–1160.
20. Burns E, Austin CA, Bax ND. Elderly patients' understanding of their drug therapy: The effect of cognitive function. Age Ageing 1990;19:236–240.
21. Meyer ME, Schuna AA. Assessment of geriatric patients' functional ability to take medication. DICP 1989;23:171–174.
22. Ruscin JM, Semla TP. Assessment of medication management skills in older outpatients. Ann Pharmacother 1996;30:1083–1088.
23. Nakamura T, Meguro K, Sasaki H. Relationship between falls and stride length variability in senile dementia of the Alzheimer type. Gerontologist 1996;42:108–113.
24. Gill TM, Williams CS, Mendes de Leon CF, Tinetti ME. The role of change in physical performance in determining risk for dependence in activities of daily living among nondisabled community-living elderly persons. J Clin Epidemiol 1997;50:765–772.
25. Isaac LM, Tamblyn RM. Compliance and cognitive function: A methodological approach to measuring unintentional errors in medication compliance in the elderly. McGill-Calgary Drug Research Team. Gerontologist 1993;33: 772–781.

26. Tinetti ME, Inouye SK, Gill TM, Doucette JT. Shared risk factors for falls, incontinence, and functional dependence. Unifying the approach to geriatric syndromes. JAMA 1995;273:1348–1353.
27. Lawton MP, Brody EM. Assessment of older people: Self-maintaining and instrumental activities of daily living. Gerontologist 1969;9:179–186.
28. Physician's Desk Reference. Montvale, NJ: Medical Economics Company, 1996.
29. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity longitudinal studies: Development and validation. J Chronic Dis 1987;40:373–383.
30. Katz S, Ford AB, Moskowitz RW et al. Studies of illness in the aged. The Index of ADL: A standardized measure of biological and psychosocial function. JAMA 1963;185:914–919.
31. Folstein MF, Folstein SE, McHugh PR. Mini-Mental State. A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–198.
32. Yesavage JA, Sheikh JI. Geriatric depression scale (GDS): Recent evidence and development of a shorter version. Clin Gerontol 1986;5:165–173.
33. Podsiadlo D, Richardson S. The timed "Up and Go": A basic test of functional mobility. J Am Geriatr Soc 1991;39:142.
34. Leitman MW. Manual for Eye Examination and Diagnosis. Oradell, NJ: Medical Economics Books, 1946.
35. Park DC, Morrell RW, Frieske D, Kincaid D. Medication adherence behaviors in older adults: Effects of external cognitive supports. Psychol Aging 1992;7:252–256.
36. Gray SL, Sager MA, Lestico MR, Jalaluddin M. Depression, cognitive impairment, and understanding of medication directions in hospitalized elderly patients. Pharm Res 1997;14:316–319.
37. Gurwitz JH, Avorn J. The ambiguous relation between aging and adverse drug reactions. Ann Intern Med 1991;114:956–966.
38. Hamann C, Wei JY. Disease prevention, health promotion, and health protection. In: Wei JY, ed. Geriatric Medicine: A Case-Based Manual. New York: Oxford University Press, 1997.
39. Bond WS, Hussar DA. Detection methods and strategies for improving medication compliance. Am J Hosp Pharm 1991;48:1978–1988.
40. Hammarlund ER, Ostrum JR, Kethley AJ. The effects of drug counseling and other educational strategies on drug utilization in the elderly. Med Care 1985;23:1165–179.
41. Keram S, Williams ME. Quantifying the ease or difficulty older persons experience in opening medication containers. J Am Geriatr Soc 1998;36:198–201.
42. McDermott MM, Schmitt B, Wallner E. Impact of medication nonadherence on coronary heart disease outcome: A critical review. Arch Intern Med 1997;157:1921–1929.
43. Gilchrist WJ, Lee YC, Tam HC et al. Prospective study of drug reporting by general practitioners for an elderly population referred to a geriatric clinic. Br Med J (Clin Res Ed) 1987;294:289–290.

APPENDIX A
Visual Aid

Time	Meals	Medication
7 am		
8 am	Breakfast	
9 am		
10 am		
11 am		
12 Noon	Lunch	
1 pm		
2 pm		
3 pm		
4 pm		
5 pm		
6 pm	Dinner	
7 pm		
8 pm		
9 pm		
10 pm	Bedtime	
11 pm		

APPENDIX B
Drug Regimen Unassisted Grading Scale

Medication List (container or chart)	Medication List (self-report)	Identification		Access		Dosage		Timing	
		Able	Unable	Able	Unable	Able	Unable	Able	Unable
Maximum Score:		Total Score:				Summary Score:			%
Total Medications:				Total Doses:					
Time:									