Title

Responsiveness of Health Status Measures to Change among Older Adults

Journal

Journal of the American Geriatrics Society, 41(3)

ISSN

0002-8614

Authors

Wagner, Edward H
LaCroix, Andrea Z
Grothaus, Louis C
et al.

Publication Date

1993-03-01

DOI

10.1111/j.1532-5415.1993.tb06700.x

Peer reviewed

Responsiveness of Health Status Measures to Change among Older Adults

Edward H. Wagner, MD† Andrea Z. LaCroix, PhD,*† Louis C. Grothaus, MS,* and Julia A. Hecht, PhD**

Objective: This study examines the ability of commonly used self-reported health status measures to detect important changes in health (responsiveness) in older adults.

Design: We compared changes in health status measures over the year among subgroups of a cohort of seniors: those who experienced an intervening illness, hospitalization or increase in drug regimen, and those who didn't. Differences between the two groups in changes in the measures were quantitated using Guyatt's responsiveness statistic and receiver operating characteristic curves (ROC).

Setting: Staff model HMO.

Participants: 1379 senior HMO enrollees who were participants in a health promotion trial and provided complete information at baseline and one year later.

Measurements: The following self-reported health status measures were evaluated: restricted activity days, bed disability days, the Medical Outcomes Study physical function scale, self-evaluated health, and a positive affect scale.

Main Results: All measures except the positive affect scale were able to discriminate significantly between seniors who were or were not hospitalized and/or reported a major illness in the intervening year. The two disability days measures showed the best responsiveness for all indicators of worsening health and included 70%–80% of the area under the ROC curves for major illness defined by hospitalization or self-report.

Conclusions: Commonly used, brief self-reported physical health status measures are responsive to intervening illness among relatively healthy seniors supporting their use in longitudinal geriatric research. **J Am Geriatr Soc 41:241–248, 1993**

The prevention of disability and the preservation of independence have become the clinical and policy priorities for the health care of older adults. Assessing the risk factors for disability and testing the efficacy of interventions require outcome measures of health and functional status capable of capturing clinically important changes in health, declines or improvements. The ability of a health status measure to detect clinically important changes in health status has been labeled its responsiveness.[1–5] The limited literature on the responsiveness of health status measures has tended to focus on specific clinical conditions such as arthritis,[6,7] low back pain,[1,8] or breast cancer.[9] In these situations, specific, focused health status measures appear to be more responsive than global ones. To our knowledge, no published studies have examined the responsiveness of commonly used *global* health status indicators in clinically heterogeneous older populations.

Older measures of responsiveness failed to account for variability in change measures in stable subjects, whatever their cause. Two more recent approaches to assessing responsiveness address this potential problem.[2,8] Guyatt and colleagues[2] proposed assessing responsiveness by using the ratio of the minimal clinically important change to variation among individuals who haven't changed. The higher the ratio, the more responsive the measure. Deyo et al[8] suggested that responsiveness be estimated by the ability of the measure to classify accurately changed and unchanged individuals, using sensitivity, specificity, and receiver operating curves. Both approaches require data from two sets of patients similar at baseline—a group that has improved or deteriorated and a group that has remained stable.

The availability of a large study population of older adults for whom we had interview and health care utilization information over a period of time provided an opportunity to compare changes in self-reported health status measures with more objective indicators of worsening health. Specifically, we examined the responsiveness of self-evaluated health, numbers of restricted activity days and bed days, the Medical Outcomes Study physical limitations scale,[10] and the positive affect scale used in the Health Insurance Experiment[11] by comparing changes in these measures among older individuals with and without evidence of major intervening illnesses.

METHODS

The study population consisted of older enrollees of Group Health Cooperative of Puget Sound (GHC) who agreed to participate in a randomized clinical trial of health promotion interventions involving a nurse-educator assessment visit and behavioral interventions.[12] Enrollees 65 years and older receiving care from three central Seattle GHC clinics were randomly selected from computerized files, and, with the permission of their primary care physicians, invited to participate in the trial. Recruitment proceeded entirely by mail. Participation involved completing and returning a lengthy questionnaire and a consent form agreeing to being randomized to intervention or control groups. Of the original random sample of 6,328, 37% returned

From the *Center for Health Studies, Group Health Cooperative of Puget Sound; and the †Center for Health Promotion in Older Adults, University of Washington School of Public Health and Community Medicine, Seattle, Washington.

This work was supported by grant (R48/CCR002181-05) from the Centers for Disease Control and was presented in part at the annual meeting of the Gerontologic Society of America, San Francisco, California 1991.

Address correspondence to Edward H. Wagner, MD, Center for Health Studies, Group Health Cooperative of Pudget Sound, Metropolitan Park II, 1730 Minor Ave., Seattle, WA 98101.

0002-8614/93/$3.50

completed materials, 8% were excluded by their physicians because of serious mental or physical illness, 13% refused, 2% were ineligible (institutionalized, out of area, too ill), and 40% failed to respond. Physician and patient refusals and ineligibles were older and more likely to have significant illness than the other groups. We interviewed a random sample of non-respondents and found them to be less well educated and less affluent but similar in health status to participants.[12]

The baseline questionnaire sought detailed information about health status, sociodemographic characteristics, health behaviors, and social support. We generally selected widely used items and scales.[13] Respondents received a follow-up questionnaire approximately 1 year after receipt of the baseline questionnaire. The follow-up questionnaire included a subset of the items in the baseline questionnaire and was also administered by mail. In those cases where mailed responses were not returned (less than 5% of respondents), we interviewed them by telephone. The overall response rate to the follow-up survey was 97%, with the majority of non-response due to death. Table 1 provides detailed information about the health status measures included in both questionnaires and whose responsiveness is reported in this paper.

Restricted activity days and bed disability days are two traditional measures of disability with a long history of use in the National Health Interview Survey.[14] In a previous report, we examined the construct validity of restricted activity and bed disability days as measures of physical disability and found strong support for their cross-sectional validity.[13] Because the distributions of these variables are so highly skewed, for most analyses we categorized them into five ordinal categories (0 = 0 days, 1 = 1–7 days, 2 = 8–30 days, 3

TABLE 1. SELF-REPORTED HEALTLH STATUS MEASURES AND INDICATORS OF WORSENING HEALTH

Health Measure	Description and/or Item Content	Source
Self-Reported Health Status Measures		
Disability days		
Restricted activity days	Two items: "In the past 12 months, did you cut down the things you usually do, such as going to work or working around the house, because of illness or injury?" IF YES: "How many days did you cut down on the things you usually do because of illness or injury?"	Adapted from NHIS[9]
Bed days	Two items: "In the past 12 months, did you ever stay in bed because of an illness or injury?" IF YES: "How many days did you stay in bed at least half the day because of illness or injury?"	Adapted from NHIS[9]
Other Health status measures		
MOS physical function	"For how long has your health limited you in each of the following activities? Vigorous activities; moderate activities, walking uphill or climbing stairs; bending, stooping or lifting; walking one block; eating, using the toilet. Responses include "for 3 months or less", "for 3 months or more", or "not limited at all". Either of the first two responses were scored as a limitation. Scored as a Guttman scale ranging from 0 (no limitations) to 6 (limitation in eating dressing, bathing or the toilet). Coefficient of reproducibility = .91, coefficient of scalability = .61.	Adapted from Ware[10,11]
Positive Affect/ Pep and Vitality	Combined score from 10-item Positive Affect subscale and a number of items from a second subscale (Pep and Vitality): "During the past month . . . (a) how much of the time have you felt that the future looks hopeful and promising? . . . (m) how much energy, pep or vitality did you have or feel?" (6 response categories).	Adapted from Veit[15]
Self evaluated health	Single item: "Would you say, in general, your health is (1) excellent . . . (5) poor?"	Ware[11]
Indicators of Worsening Health		
1. Major hospitalization	Any hospitalization in the past 12 months with a primary discharge diagnosis of myocardial infarction, other heart disease, cerebrovascular disease (excluding TIA), hip fracture, Alzheimer's disease, Cancer (lung, breast, colon or rectum, prostate, Other GI).	
2. Minor hospitalization	Hospitalization with any other primary discharge diagnosis.	
3. Major illness	Single item: "In the past 12 months, have you had a major personal illness?"	
4. Chronic Disease Score	Weighted sum of drugs taken for major chronic diseases such as hypertension, diabetes, asthma/emphysema, malignancy. Higher scores mean more complex regimens. An increase in the score of two or more points used as indicator of worsening health.	

= 31–179 days, and 4 = 180+ days). The responsiveness of the six-item version of the MOS physical limitations scale is also evaluated in this report; cross-sectional construct validity and internal consistency reliability have been demonstrated by the instrument's creators.[10] The six items of the MOS physical limitations scale conformed to a Guttman scale,[13] and respondents were given a score ranging from 0–6, where 0 indicated no limitations in any activity and 6 indicated limitations in self-care activities. Finally, we evaluated the responsiveness of a single-item measure of self-evaluated health and a scale indicating psychologic well being entitled Positive Affect.[11]

The assessment of responsiveness requires the dichotomization of the study population into a group whose health status has changed and one whose health status has remained unchanged. As we are interested in preventing declines in the health status of older adults, we looked for indicators strongly suggestive of worsening health that were independent of the self-reported measures of health status.

Table 1 defines the indicators of worsening health studied in this report. In each instance, they reflect events occurring in the year between the baseline and follow-up questionnaires. GHC hospital and pharmacy computer systems provided the data to assess the occurrence of hospitalizations and the Chronic Disease Score, respectively. We limited major hospitalizations to those in which the primary discharge diagnosis was a serious illness or injury with a high likelihood of residual dysfunction in this age group. All other hospitalizations were categorized as "minor" and analyzed as a separate indicator of worsening health. The Chronic Disease Score is a measure derived from computerized pharmacy data reflecting the number and severity of chronic conditions. The score has been shown to be highly predictive of death, hospitalization, and ambulatory utilization in a variety of GHC study populations.[15] The mean score for this population was about three; an increase of two or more points over the year was used as the indicator of worsening health. A fourth indicator of worsening health was the self-report of a major personal illness between baseline and the follow-up questionnaire.

For each indicator of worsening health, we classified individuals as having worsened or not and compared self-report measures between these two groups for each indicator. The group that did not worsen includes those who either improved (eg, hospitalized in the year prior to baseline but not in the year after) or stayed the same (eg, hospitalized in both years or neither year).

Missing values were relatively frequent among the self-report measures. We therefore confined the comparative analyses of health status measures to the 66% of respondents ($n = 1,379$) for whom we have complete baseline and follow-up data on all measures in Table 1. The difference between zero and the mean change within a group (eg, among those hospitalized) and the difference in mean changes between groups (eg, hospitalized vs non-hospitalized) were tested using t tests. We used analysis of covariance for analogous tests controlling for baseline health status.

Receiver-operating characteristic curves were constructed in the standard way by computing and plotting the sensitivity and 1-specificity of changes of different sizes for each health status measure. The area under each ROC curve and its standard error were computed using the trapezoidal method,[16] and a z test assessed the significance of the difference from 0.5, the null value.

RESULTS

Table 2 shows health status measure means at baseline and follow-up for the 1,379 respondents for whom we have complete data. Overall, changes were small, mixed in sign (positive changes indicate worsening health), and only significantly worse for self-evaluated health status.

Changes in health status measures differed significantly depending on whether the subject had one of the intervening indicators of worsening health (Table 3). Forty-eight individuals (3.5%) had one or more major hospitalizations in the intervening year. While their self-reported health status measures were only somewhat worse at baseline than those not hospitalized, each health status measure except positive affect significantly changed for the worse at follow-up. In contrast, the 1,334 seniors not experiencing a major hospitalization showed no significant changes. For the 111 (9.9%) seniors with a "minor" hospitalization, all measures worsened, but the changes were smaller than with major hospitalizations, and only bed days and restricted activity days changed significantly.

TABLE 2. SUMMARY STATISTICS FOR INDEPENDENT HEALTH STATUS VARIABLES

Health Status Variable	Mean for Period			*P*-value for change
	Pre	Post	Change	
Bed days last 12 Months	1.80	2.27	0.47	0.22
Bed days last 12 Months (5-point scale)	1.07	1.09	0.02	0.28
Restricted days last 12 Mo.	12.27	12.18	−0.09	0.96
Restricted days last 12 Mo. (5-pt scale)	1.21	1.25	0.03	0.37
MOS scale (Guttman)	1.51	1.46	−0.04	0.35
Self-evaluated health	2.48	2.54	0.06	0.001
Positive affect	24.74	24.91	0.16	0.36

Based on sample of 1379 with complete data on all outcome and independent health status variables.
Pre-period refers to 12 months prior to baseline survey. Post-period refers to 12 months after baseline survey.
P-value for change indicates whether a statistically significant change occurred from pre to post period in the population overall.

TABLE 3. BASELINE HEALTH STATUS AND CHANGE OVER ONE YEAR IN THOSE WITH AND WITHOUT AN INDICATOR OF WORSENING HEALTH (N = 1379)

Health Status Variable	Without Indicator				With Indicators		
	Mean for Period				Mean for Period		
	Baseline	Change	Standard Deviation of Change	P-Value	Baseline	Change	P-Value
Major hospitalization							
Bed days 12 months	1.31	−0.01	0.73	NS	1.46	0.89	***
Restricted days 12 mo	1.48	−0.01	1.10	NS	2.07	1.28	***
MOS (Guttman)	1.49	−0.08	1.83	NS	1.89	0.94	***
Self-evaluated health	2.47	0.06	0.73	NS	2.59	0.33	***
Positive affect	24.74	0.15	6.21	NS	24.93	0.33	NS
Minor hospitalization							
Bed days 12 months	1.31	−0.01	0.71	NS	1.36	0.41	***
Restricted days 12 mo	1.50	−0.03	1.07	NS	1.49	0.69	***
MOS (Guttman)	1.49	−0.05	1.78	NS	1.65	0.04	NS
Self-evaluated health	2.48	0.06	0.71	**	2.48	0.14	NS
Positive affect	24.64	0.14	6.41	NS	25.96	0.38	NS
Major illness							
Bed days 12 months	1.32	−0.09	0.69	***	1.26	0.97	***
Restricted days 12 mo	1.51	−0.13	1.04	***	1.40	1.48	***
MOS (Guttman)	1.47	−0.14	1.73	**	1.79	0.80	***
Self-evaluated health	2.46	0.04	0.69	*	2.60	0.30	***
Positive affect	24.70	−0.03	5.88	NS	25.16	1.85	***
Worse chronic disease score							
Bed days 12 months	1.31	−0.02	0.69	NS	1.32	0.31	***
Restricted days 12 mo	1.49	−0.03	1.04	NS	1.56	0.40	***
MOS (Guttman)	1.46	−0.08	1.73	NS	1.81	0.22	NS
Self-evaluated health	2.46	0.03	0.69	NS	2.59	0.26	***
Positive affect	24.71	−0.04	6.23	NS	24.98	1.49	**

P-values:
*** = .001.
** = .01.
* = .05.
NS = Not significant (P > .05).

The differences between the 185 (13.4%) individuals who reported at follow-up a new major illness in the prior 12 months and the 1,194 who didn't were even more striking. On three of the five measures, those not reporting an illness significantly improved over the ensuing year, while those with an illness deteriorated on all measures. Thirteen percent (183) of individuals experienced an intensification of their chronic disease drug regimen in the intervening year. Compared with the rest of the population, this group also showed significant declines in health status, reaching statistical significance for all measures except the MOS physical limitations scale.

The mean change of the measure among those with an indicator of worsening health (6th column, Table 3) and the standard deviation of the changes in those with no intervening event (3rd column, Table 3) serve as the numerator and denominator, respectively, of the responsiveness measure proposed by Guyatt et al.[2] Higher ratios indicate greater responsiveness to change in health status. Figure 1 summarizes the responsiveness indices of each self-reported health status measure for the four intervening health events. For all indicators of worsening health except the increase in chronic disease score, responsiveness was greatest for the two measures of disability days, intermediate for the MOS physical limitations scale and self-evaluated health, and lowest for positive affect.

Using ROC curves, we next examined the ability of changes in health status measures of varying size to differentiate among individuals with and without intervening events. Figures 2 and 3 summarize the results for major hospitalization and major illness. The diagonal dotted line displays points at which the measure is performing no better than chance, where the decline in health status is just as likely to be a true or a false positive. The most useful measures are those whose ROC curves approach the upper left hand corner, the point at which the measure perfectly distinguishes between those who have and have not had the intervening illness event.

Figure 2 shows the ROC curves reflecting different degrees of change in the five self-reported health status measures to detect individuals with an intervening major hospitalization. The ROC curves for increases in bed days and restricted activity days and higher scores on MOS physical limitations scale all include an area under the curve significantly greater than 0.5 with $P <$ 0.001. The two disability days measures enclose nearly three-quarters of the area under the curve, substantially more than the MOS physical limitations measure. Changes in self-evaluated health account for an area

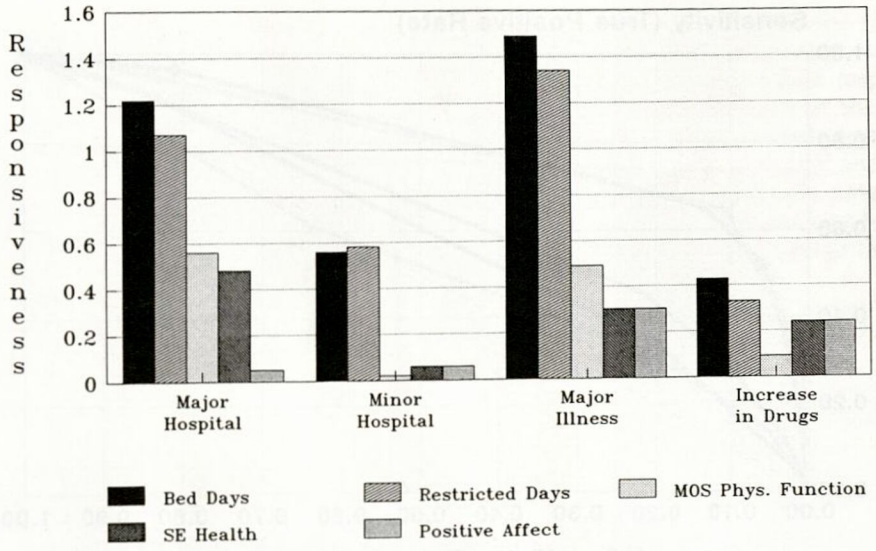

FIGURE 1. Responsiveness of health measures: measure of Guyatt et al.

under the curve similar to the MOS but with $P = 0.05$. Changes in positive affect scores could not distinguish those with and without a major hospitalization better than chance.

For major illness, the picture is nearly identical (Figure 3), and the rank ordering of measures remains the same. The curves for the two measures of disability days include approximately 80% of the area under the curve, 15% more than with the MOS measure or self-evaluated health. All are significantly different from 0.5 with $P < 0.001$. The positive affect scale again performs no better than chance.

Figure 4 summarizes the areas under the ROC curves for all indicators of worsening including minor hospitalizations and increases in chronic disease medications. The ordering of measures by the area included under the curve is strikingly similar to that seen with the responsiveness measure of Guyatt and colleagues[2] shown in Figure 1.

DISCUSSION

There are several features of our methodological approach worthy of further scrutiny. First, the population is limited to HMO enrollees willing and able to

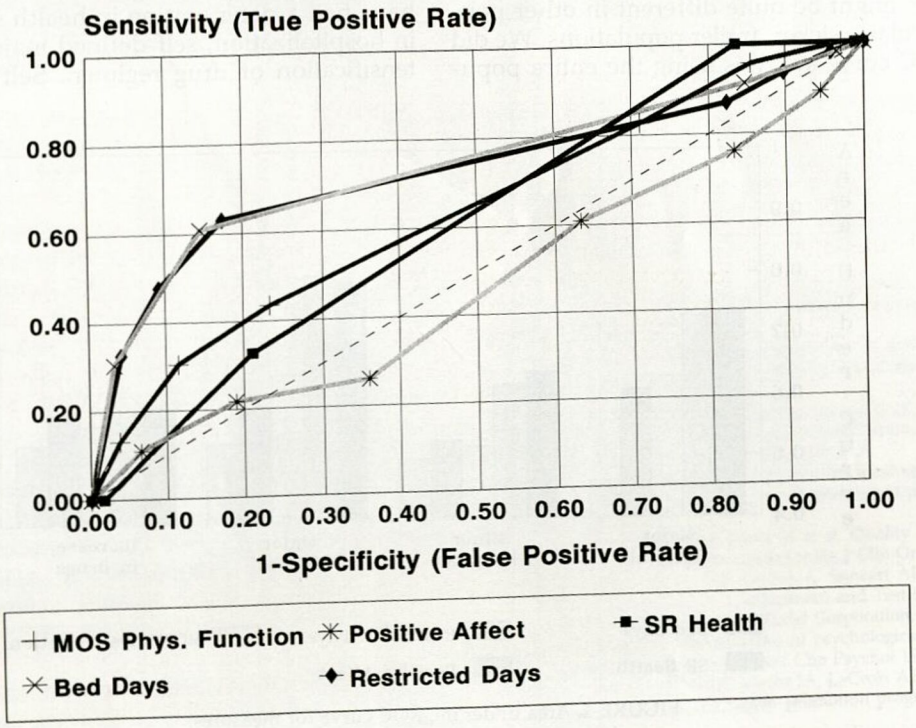

FIGURE 2. ROC curves for major hospitalization.

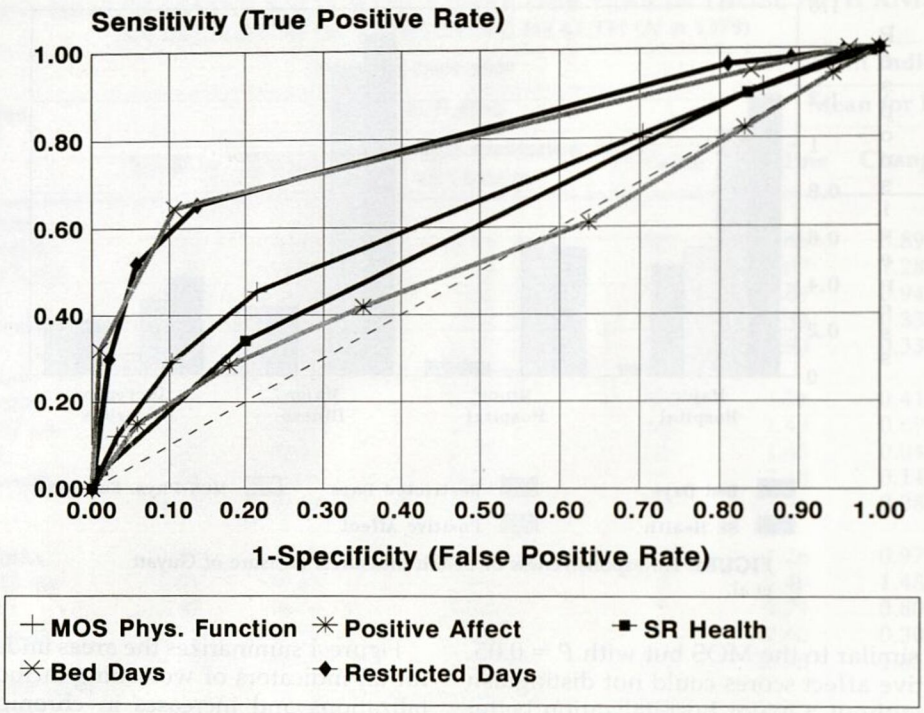

FIGURE 3. ROC curves for major illness.

participate in a randomized trial of health promotion. This excludes some of the sickest segment of the population. Second, we excluded from the analysis the 34% of respondents with missing data, and previous work indicates that missing data are strongly correlated with older age and reduced health status.[13] As a result, our findings derive from a relatively healthy group of older HMO enrollees, and the responsiveness of these measures might be quite different in other populations, particularly sicker, frailer populations. We did repeat the ROC curve analysis using the entire population that had available data on each of the health status measures, and the results were similar.

Third, one can question our selection of criterion indicators of health status change. None of our indicators are necessarily associated with declines in functional status, particularly declines lasting as long as 1 year, the interval between surveys. Conversely, individuals not experiencing a criterion indicator may well have had a deterioration in health status not resulting in hospitalization, self-defined major illness, or an intensification of drug regimen. Self-defined major ill-

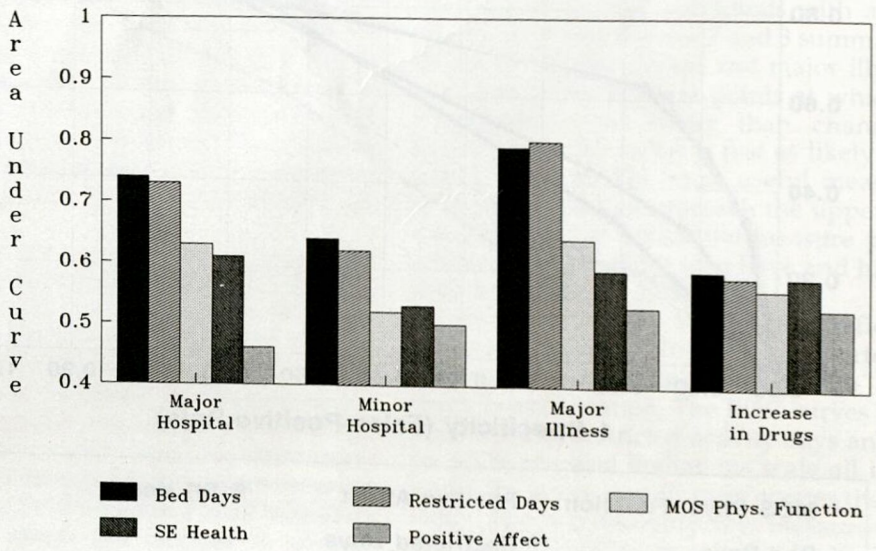

FIGURE 4. Area under the ROC curve for measures.

ness and minor hospitalizations are likely to include events that had minimal impact on functional status. An increase in the number of drugs prescribed for various chronic diseases may well be associated with better disease control and improved function, not just declines resulting from increased disease severity. While we limited major hospitalizations to serious illnesses likely to have long-term consequences on health status, full recovery from myocardial infarction, stroke, hip fracture, and some of the cancers included in this category is not infrequent. Other than the change in Chronic Disease Score, each indicator, therefore, reflected events that occurred as long as 1 year previously, and any deleterious effect on function may have ended.

Given the fact that the criterion events may have been remote in time or minimal in impact, the responsiveness of the best measures is quite impressive. Our data suggest that episodes of major illness and hospitalization in older adults are followed by declines in function as measured by several frequently used indicators of physical health. Increases in the standard disability days measures used in National Center for Health Statistics surveys were associated with the best responsiveness scores. Two other frequently used measures of physical health status, the MOS physical function scale and the comparative health self-evaluation question, also proved to be responsive to intervening illness. We scored the MOS physical function scale as a Guttman scale (ie, score determined by least demanding activity with which respondent reported difficulty) rather than as a cumulative score as proposed by the originators.[10] Repeating the ROC analyses using the published scoring method found the recommended scores to be somewhat less responsive than the Guttman scale approach. The positive affect scale was no better than chance in discriminating between individuals with and without each of the intervening illness indicators.

The higher responsiveness of the disability days measures was true, regardless of whether we used the actual number of bed or restricted activity days or categories such as 0, 1–7, 8–30, 31–179, and 180+ days as shown in the tables and figures. Since hospital days may well be interpreted by a respondent as both bed and restricted activity days, we wondered whether that might account for some of the association with hospitalization independent of any true change in health status. To check this, we subtracted the actual days spent in hospital from reported bed and restricted activity days and repeated the analyses; this did not change the ROC curves in any way. The ROC curve analyses indicate that a deterioration of one disability day category, eg, from 1–7 days to 8–30 days, is too non-specific, while a change of four categories, eg, 0 days to 180+ days, is too insensitive. Based on these analyses, we used a change of two categories as an indicator of a decline or improvement in function in a recent analysis.[17]

The fact that the hospitalization or illness could have occurred at any time in the intervening year may account for the better responsiveness of the disability days measures, which asked the respondent to aggregate periods of limited function over the previous 12-month period. We also asked respondents about bed and restricted activity days in the past 2 weeks. The responsiveness of the 2-week measures was less than that of the 12-month measures and similar to that seen with the MOS physical functioning scale. This suggests that the time interval probed by a health status measure may be an important determinant of its responsiveness to various clinical changes.

The two disability days measures are estimates of the time spent in a disabled state defined only by "cutting down on the things you usually do" or "stay(ing) in bed." They measure the duration of disability more than its extent. In contrast, changes in the MOS physical limitations scale or the self-evaluated health question require changes in the severity of disability or reduced health status; for example, a worsening of disability from limitation in the ability to walk uphill or a few flights of stairs (with preserved ability to walk one block) to loss of the ability to walk one block. Therefore, restricted activity days and bed disability days may be particularly useful in evaluating functional status over periods of time such as before, during, and following interventions to reduce disability. The MOS physical function scale and self-evaluated health question provide complementary information about status at present.

Finally, these analyses allowed us to compare two approaches to measuring responsiveness or sensitivity to change. The methods of Deyo and Centor[1,8] and Guyatt et al[2] generated very similar results. In summary, brief, global indicators of physical function and health were responsive to intervening illness or injury in the previous year, supporting their use in longitudinal observational and intervention research.

REFERENCES

1. Deyo RA. Measuring functional outcomes in therapeutic trials for chronic disease. Controlled Clin Trials 1984;5:223–240.
2. Guyatt G, Walter S, Norman G. Measuring change over time: Assessing the usefulness of evaluative instruments. J Chron Dis 1987;40:171–178.
3. Feinstein AR, Josephy BR, Wells CK. Scientific and clinical problems in indexes of functional disability. Ann Intern Med 1986;105:413–420.
4. Guyatt GH, Deyo RA, Charlson M, et al. Responsiveness and validity in health status measurement: A clarification. J Clin Epidemiol 1989;42: 403–408.
5. Deyo RA, Diehr P, Patrick DL. Reproducibility and responsiveness of health status measures: Statistics and strategies for evaluation. Controlled Clin Trials 1991;12:142S–158S.
6. Anderson JJ, Firschein HE, Meenan RF. Sensitivity of a health status measure to short-term clinical changes in arthritis. Arthritis Rheum 1989; 32:844–850.
7. Liang MH, Larson MG, Cullen KE, Schwartz JA. Comparative measurement efficiency and sensitivity of five health status instruments for arthritis research. Arthritis Rheum 1985;28:542–547.
8. Deyo RA, Centor RM. Assessing the responsiveness of functional scales to clinical change: An analogy to diagnostic test performance. J Chron Dis 1986;39:897–906.
9. Levine MN, Guyatt GH, Gent M et al. Quality of life in stage II breast cancer: An instrument for clinical trials. J Clin Oncol 1988;6:1798–1810.
10. Ware JE, Sherbourne CD, Davies A, Stewart AL. The MOS Short-Form General Health Survey: Development and Test in a General Population. Santa Monica California: The Rand Corporation, 1988.
11. Veit CT, Ware JE. The structure of psychological distress and well-being in general populations. J Consult Clin Psychol 1985;51:730–742.
12. Wagner EH, Grothaus LC, Hecht JA, LaCroix AZ. Factors associated with participation in a senior health promotion program. Gerontologist 1991; 31:598–602.

13. Scholes D, LaCroix AZ, Wagner EH et al. Tracking progress towards national health objectives in the elderly: What do restricted activity days signify? Am J Public Health 1991;81:485–488.
14. National Center for Health Statistics. Current estimates from the National Health Interview Survey: United States 1986. Vital and Health Statistics 1986;10(160).
15. Von Korff M, Wagner EH, Saunders K. A chronic disease score from automated pharmacy data: Is it confounded with utilization? J Clin Epidemiol 1992;45:197–203.
16. Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. Radiology 1982;143:29–36.
17. Leveille SG, LaCroix AZ, Hecht JA et al. The cost of disability in older women and opportunities for prevention. J Women's Health 1992;1: 53–61.