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Comorbidity in Aging and Dementia: Scales Differ, and the Difference Matters

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Abstract

Background—Accurate assessment of dementia's impact on health care utilization and costs requires separation of the effects of comorbid conditions, often poorly accounted for in existing claims-based studies.

Objective—To determine whether two different types of comorbidity and risk adjustment scales, the Chronic Disease Score (CDS) and the Cumulative Illness Rating Scale for Geriatrics (CIRS-G) perform similarly in older persons with and without dementia.

Method—All subjects in the community-outreach diagnostic program of the University of Washington Alzheimer's Disease Research Center Satellite were included (n=619). Subjects' mean age was 75±9 years; 40% were cognitively normal, 17% were cognitively impaired-not demented (CIND), and 43% were demented. CDS and CIRS-G scores (neuropsychiatric disorders excluded to reduce co linearity with group) were examined across strata of age, education, and cognitive classification, using ANOVA, ANCOVA, and linear regression.

Results—CIRS-G scores were sensitive to factors known to be associated with chronic disease burden, including age ($F = 21.3$ [df 2,616], $p < 0.001$), education ($F = 6.6$ [df 3, 614], $p < 0.001$), and cognitive status ($F = 40.5$ [df 2, 616], $p < 0.001$), while the CDS was not. In the subset of persons with CDS scores of 0 (40% of the total sample), CIRS-G scores ranged from very low to high burden of disease, and remained significantly different across age, education, and cognitive status groups. In regression analyses predicting CIRS-G score, CDS score and cognitive status interacted ($\beta = -0.10$, $t = 1.9$ [df=1,609], $p = 0.06$). After controlling for age, the amount of variance shared by the CIRS-G-13 and CDS differed by cognitive group ($> 32\%$ for normal and mildly impaired groups combined, 17% for dementia).

Conclusion—Different methods of measuring and adjusting for comorbidity are not equivalent, and dementia amplifies the discrepancies. The CDS, if used to control for comorbidity in comparative studies of health care utilization and costs for persons with and without dementia, will underestimate burden of comorbid disease and artificially inflate the costs attributed to dementia.

Keywords

Risk adjustment; Chronic Disease Score; Cumulative Illness Rating Scale for Geriatrics; elderly

Background and Objective

Valid measures of comorbidity are useful both to describe the health status of groups and to evaluate the performance of health systems in delivering high quality care for chronic disease at manageable cost. Two general types of measures have been developed: risk adjusters geared toward specific target outcomes, such as hospitalizations, acute care costs, or mortality, and comorbidity scales, which measure burden of chronic diseases. The need for simplicity in large-scale studies has favored the adoption of risk adjusters such as the Chronic Disease Score (CDS, 1) and its derivative, RxRisk (2), which score selected chronic diseases based on the use of medications associated with them. Comorbidity scales range from the Charlson Index (3) and its later iteration using ICD-9 codes (4), which select specific disorders associated with one-year hospitalization and mortality rates, to the Cumulative Illness Rating Scale (5) and its refinement for geriatric use (CIRS-G, 6), which require extensive evaluation of clinical data pertinent to disorders in all body systems and is designed to rate the severity as well as the presence of disease. Over time, the CDS/RxRisk and Charlson measures have come to be used as general indices of total disease burden in a wide range of patient demographics and populations (7). However, recent studies have raised questions about the predictive performance of these scales in older populations, for whom the impact of aggregated comorbid conditions on health care utilization and mortality differ from that of younger adults. For example, in a study predicting one-year mortality among older medical inpatients, substantial differences were found between two versions of the Charlson Index, one derived from chart review and the other from ICD-9 diagnoses catalogued in administrative data (8). In another study comparing prediction of ambulatory care costs and mortality in a large group of older patients in a primary care practice system, a simple sum of medications did as well as any other easily scored measure (9). However, no measure explained more than 20% of the variance in outcomes, indicating that other key determinants of utilization are invisible to these simple measures. Such determinants could include disease severity, total chronic disease burden, the presence of specific comorbid conditions, or psychosocial factors affecting care. A weakness shared among risk adjusters and comorbidity measures is the necessary assumption that relevant conditions are detected, diagnosed, and/or treated. Their validity can therefore be influenced by variations in physician behavior and patient access to and utilization of health care. However, the CIRS-G, because it includes information about both longitudinal disease course and current severity, and is derived from medical record, interviews with patients and other informants, and current examination and test findings, can be viewed as a comprehensive 'gold standard' for rating total burden of disease in older persons.

The accurate identification of comorbid conditions could have major practical consequences for the organization and effectiveness of health care for older adults. Following the release of the Institute of Medicine's report, "Retooling for an Aging America" (10), recently introduced federal legislation would expand geriatric health care services based on individuals' burden of disease. The "RE-Aligning Care Act" (S.1004/H.R.2307) would cover comprehensive geriatric assessment and care coordination services for Medicare beneficiaries with the most complex and costly health conditions. For non-demented persons, the presence of five or more chronic conditions would qualify a beneficiary for this service. Persons with diagnosed dementia would qualify with only one additional chronic disease, acknowledging the impact of dementia on the complexity of health care.

Significant cognitive impairment is well known to be associated with conditions that increase health care utilization, medical expenditures, and mortality (11–17), but is poorly represented in risk adjusters and comorbidity rating systems, and has not been investigated as an influence on their performance. Substantial differences in chronic disease burden as rated by different instruments could lead to inaccurate estimation of health care consequences attributed to dementia, and influence eligibility of individual older persons for the proposed Medicare care

coordination benefit. To our knowledge no previous study has evaluated whether dementia differentially influences scores on comorbidity rating scales in older adults. In this study, we characterize comorbidity in a community sample of older persons purposively enriched for those with dementia, compare scores attained on the CDS and the CIRS-G in demented and non-demented groups, and consider the implications of the findings for health care delivery.

Methods

Data Sources

All subjects enrolled in the University of Washington's Alzheimer's Disease Research Center Satellite 1992–2004 (n=620) were included. This sample was recruited by active, purposive outreach into the community, to expand enrollment beyond the typical ADRC volunteer groups. Data analyzed for this report include demographics, cognitive function and Clinical Dementia Rating classification (normal, CDR 0; cognitively impaired not demented [CIND], CDR 0.5; demented, CDR ≥ 1), and comorbidity ratings by the CDS and the CIRS-G completed at subjects' enrollment visit.

Scoring comorbidity measures

CDS. A research nurse inspected all medications for each subject during a home visit and confirmed duration of prescription use. The CDS scores medications used for cardiovascular and respiratory diseases, cancer, diabetes, gout, ulcers, rheumatoid arthritis, and Parkinson's disease, among others (but not dementia). The **CIRS-G** scores diseases in 14 organ systems and grades each according to severity using explicit rules for classification. To isolate any effect of dementia, reduce confounding by dementia-related psychiatric symptoms, and increase consistency with the CDS, we eliminated the neuropsychiatric item of the CIRS-G (which includes all dementia diagnoses as well as primary psychiatric illnesses such as major depression and schizophrenia), leaving 13 systems to comprise a total score, referred to henceforth as CIRS-G-13. Data for CIRS-G-13 scoring were compiled from comprehensive patient and informant interviews, review of medical history, records and tests, and current physical examination findings. The total CIRS-G-13 score was independently scored by two experienced research physicians in 200 randomly selected subjects to establish inter-rater reliability (intraclass coefficient 0.93 for total score). Following analyses recently reported in a study of geriatric medical inpatients (18), we computed a severity score, denoting the mean of summary scores across 13 organ systems, and an index of comorbidity (CM2). CM2 denotes the number of CIRS-G-13 organ systems with disease severity scored ≥ 2 (moderate, severe, and extremely severe). This measure, with a maximum score of 13, is useful to isolate active and more severe chronic conditions that are a current focus of treatment, not merely conditions that had been present at some time in the past but are no longer active.

Data analyses

Univariate—First, we used a series of ANOVAs to examine the CIRS-G and the CDS across demographic (age, education) and clinical (cognitive impairment) groups. The known associations of advanced age, low education and dementia with poor health outcomes led us to expect differences in comorbidity measures.

Second, we investigated CIRS-G relationships with demographic variables in subjects for whom the CDS score was 0. CDS scores were skewed and yielded a zero score for 40% of the sample, while CIRS-G scores were normally distributed and yielded a non-zero score for all but 0.3 % of subjects. We therefore suspected that there might be substantial useful information in the CDS=0 subgroup, which could be revealed by the CIRS-G to be a function of demographic or clinical differences. To address this question, we repeated all univariate analyses in the CDS = 0 subgroup.

Regression and interactions—Third, we used linear regression, with the CIRS-G-13 as the outcome, and age, education, cognitive status, CDS score, and their interactions as independent predictor variables. Because the CDS and all of the listed demographic variables were related to the CIRS-G in univariate analyses, a regression model testing all terms was necessary to determine which ones uniquely predicted variance in the CIRS-G. CDS interactions with age, cognitive status and education were tested in this process. The final regression model retained all significant variables and variables necessary to support interactions at $p < 0.10$.

All analyses were performed in SPSS 17.

Results

Table 1 shows demographic and clinical characteristics of the sample grouped by cognitive status (normal, CIND, demented).

Univariate analyses relating age, education, and cognitive status to comorbidity measures in the sample as a whole (Figure 1) showed significant relationships for each with CIRS-G-13 total scores (all $p < 0.001$) but none had a significant relationship with the CDS (all $p > 0.10$).

In the 40% of subjects with CDS scores of 0, age, education, and cognitive status maintained their significant relationships with CIRS-G-13 total score. Age group differences in mean (sd) CIRS-G-13 scores were 5.4 (3.9) for ages < 70 , 7.5 (3.4) for ages 70–79, and 8.8 (3.9) for age 80+, $F = 15.3$, $df = 2, 236$, $p < 0.001$. Education group differences in CIRS-G-13 scores were 9.0 (4.0) for < 5 years, 8.4 (4.5) for 5–8 years, 6.8 (3.6) for 9–12 years, and 6.0 (3.4) for 13+ years ($F = 7.9$, $df = 3, 235$, $p < 0.001$). Across cognitive status groups, CIRS-G-13 scores were lowest for the normal group at 5.2 (2.8), intermediate for the CIND group at 7.0 (3.2), and highest in the demented group at 9.0 (4.1) ($F = 29.7$, $df = 2, 236$, $p < 0.001$). Figure 2 shows that differences in CIRS-G-13 mean (sd) scores across cognitive strata persist after controlling for age and education effects (see figure legend for details).

To investigate further whether subjects with CDS scores of 0 had comorbid conditions likely to impact overall health (rated by CIRS-G-13), we examined individual organ system categories scored as present on the CIRS-G-13. CIRS-G-13 disorders with the largest percentage of cases missed by the CDS were cardiovascular, gastrointestinal, musculoskeletal (mainly osteoarthritis), and endocrine/metabolic (mainly diabetes). CIRS-G-13 scores in this CDS = 0 group ranged from 5.7 to 19, indicating mild to moderate comorbidity.

Regression and interaction analyses

Since univariate analyses found significant relations between cognitive status, age, education, and CDS scores with CIRS-G-13, multiple regression was used to assess the contribution of each variable to CIRS-G-13 as the dependent variable, and interactions among these variables. The final model predicting CIRS-G-13 scores included four terms: CDS ($\beta = 0.53$, $t = 12.4$ [$df = 1,609$], $p < 0.001$); cognitive impairment ($\beta = 0.30$, $t = 6.7$ [$df = 1, 609$], $p < 0.001$), age ($\beta = 0.20$, $t = 5.8$ [$df = 1,609$], $p < 0.001$), and CDS $\times$ cognitive status interaction ($\beta = -0.10$, $t = 1.9$ [$df = 1,609$], $p = 0.06$). For the overall equation, $F = 85.6$ [$df = 4, 609$], $p < 0.001$. We then conducted a post hoc examination of shared variance between the CDS and CIRS-G-13 in the three different cognitive groups. The amount of variance shared by the two comorbidity measures declined with worsening cognitive status. The amount of shared variance was similar for normal (35%) and CIND (32%) groups, but much less (17%) for the demented group. These relative values were unchanged when only moderate to severe, currently active chronic conditions (CIRS-G-13 CM2 scores) (17) were used to compare scale

performance, eliminating the possibility that the CDS under-rates comorbidity only because it emphasizes more severe and current conditions.

Discussion

The major findings of this study are that older age, lower education, and the presence of dementia are independently associated with differential performance of scales used as indicators of disease burden. While the two measures evaluated here were developed for different purposes and in different population contexts, both the CDS (and its later derivatives) and the CIRS-G have been considered generally acceptable measures of comorbidity. The CDS has the sizable advantage of automated scoring from administrative pharmacy data. However, here we show that the CIRS-G, which requires detailed clinical assessment, provides a very different picture of chronic disease burden and that the differences are magnified in the very old and persons with dementia.

Strengths of the present study are several. Both scales were completed during the same evaluation, and all prescription drugs used by subjects, and their duration of use (to ensure compatibility with the timeframe used in scoring the CDS), were confirmed by detailed inspection in the home environment supplemented by prescribing records. High inter-rater reliability for the CIRS-G was established empirically, and the sample size was nearly twice that of the largest CIRS-G study published to date (18). A limitation of our study is the use of the original CDS (1), the only version available at the outset of data collection. Subsequent refinements of the CDS (2,19) might perform somewhat better (e.g. Putnam et al, 20) against the CIRS-G, but do not overcome the weakness of ignoring dementia. Another limitation of the present study is the absence of clinical and health care utilization and cost outcomes.

The Canadian Study of Health and Aging (CSHA) is the only prior investigation we found that presented data on the CDS in persons of varying cognitive status (normal, CIND, and demented) (21), but analyses suggesting higher scores in more cognitively impaired groups (who were almost certainly older) were not age-adjusted, and statistical comparisons were not reported. The proportion of CSHA participants with zero scores on the CDS is also not reported. The CSHA used the 1995 CDS update (19), which has one major substantive difference from the original version we used (1), in that it includes medications used to treat psychiatric disorders (depression, psychosis, bipolar disorder, and anxiety). Because of the association of dementia with psychiatric symptoms, psychotropic drug use could therefore have contributed to the difference in CDS scores observed in the CSHA across cognitive strata, but this speculation cannot be confirmed from the published data.

Differential performance of comorbidity scales and risk adjusters in varying clinical and population groups is not trivial, and we have shown that conditions that are unscored on the CDS – particularly in persons with dementia – include important and common determinants of overall health such as cardiovascular disease and diabetes. With the rising prevalence of dementia in the population, understanding how, why, and to what extent affected persons use health care differently from non-demented older persons, and what value should be placed on these differences, has taken on new importance. Gauging the effect of comorbidity on utilization of health care is a crucial component of studies assessing patterns of care and associated costs for specific conditions.

Empirical comparisons of medical care costs for demented with non-demented persons diverge widely, even in very recent studies. For Medicare beneficiaries with Alzheimer's disease, cost differentials range from essentially none (22), through excess yearly costs of \$2500–3500 per demented person (23,24), topping out at a difference of more than \$22,000 (25). Which is the 'real' number that should drive policy considerations and health care design for persons with

dementia? Although adequate explanations for these large cost disparities are not to be found in the current literature, one likely source lies in methodological treatment of comorbidity. In the high cost estimate (25), comorbidity was ignored, while in the more modest estimate (24), propensity score matching for comorbidity (based on all Medicare claims diagnoses in the index year) was used to predict costs in the subsequent year. Both studies tracked similar utilization outcomes (ambulatory care, pharmacy, and inpatient care), so cost differences cannot be attributed to discrepancies in choice of which health care services were used as outcomes. This example illustrates the critical role of accurate comorbidity measurement in developing scientifically valid estimates of the effect of dementia on patterns and costs of health care.

Here we provide evidence that dementia itself might confer a kind of ‘health disparity’, inasmuch as CDS scores – based on pharmacological treatments for specified chronic conditions – were less reflective of total burden of disease in demented as compared to non-demented persons. Does this mean that physicians tend to prescribe fewer medications for chronic diseases if an individual has dementia? Physicians may under-treat chronic conditions in demented persons out of a sense of futility, as suggested by some studies (26,27), or might appropriately limit the complexity of medication regimens in patients with cognitive difficulties. Or might physicians under-recognize chronic conditions in demented persons, due to patients’ inability to report their own symptoms (12) or caregivers’ difficulty in interpreting and reporting clinically meaningful changes (which has not been formally studied to our knowledge)? Or does dementia widen the gap between physicians’ intended therapies and actual patient behaviors with respect to medication use? In any of these scenarios, fewer medications would be available for scoring the CDS, yielding spuriously low scores relative to the CIRS-G. Whatever the reason(s), analysis and prediction of health care utilization and costs for persons with dementia is likely to be significantly affected by the measures used to parse comorbidity. By underestimating true comorbidity in older persons with dementia, the CDS would overestimate use and costs of health care attributed to dementia itself.

Conclusion

Results of this study suggest that while the CDS serves a useful purpose in the system-wide prediction of health care utilization and expenditures in a general adult population, it may be a less robust measure for older adults with complex comorbidities. In our data, it is insensitive to age effects as well as to the effects of education and cognitive impairment, all of which are known modifiers of health and health economic outcomes. In contrast, the CIRS-G, though labor-intensive, is much more responsive to these important health modifiers, and its most striking advantage is observed in the presence of dementia. An ideal comorbidity measure for older populations would combine the advantages of both types of instruments – the comprehensiveness of the CIRS-G, and the simplicity and ease of automation of the CDS. Any such measure will need to account for dementia as a potentially significant modifier of health status and care.

Unscored or under-scored comorbidity has substantial consequences for comprehensive, coordinated geriatric care, as reflected in the proposed RE-Aligning Care Act. Of the 354 non-demented subjects in our sample, 46 (13%) would qualify for care coordination based on CIRS-G-13 comorbidities, but 19 (41% of qualified persons) would be rendered ineligible if the CDS were the sole measure of comorbidity. Among the 267 demented subjects, 255 (96%) would be eligible for care coordination, having at least one CIRS-G-13 chronic condition in addition to dementia, but the CDS would score 105 (41%) ineligible. The method chosen to rate comorbidity would therefore strongly influence benefit assignment and introduce an unacceptable inequity into health care reform.

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Figure 1. CIRS-G -13 v. CDS: Comparisons across age, education, and cognitive status

Graphs depict age (top), education (middle), and cognitive status (bottom) group effects.

Possible CIRS-G 13 score range 0–52, CDS 0–36. Means and standard deviations are compared by ANOVA. CIRS-G-13 mean scores differed significantly across age ($F = 21.3$ [df 2,616], $p < 0.001$), education ($F = 6.6$ [df 3, 614], $p < 0.001$), and cognitive status ($F = 40.5$ [df 2, 616], $p < 0.001$) groups. For CDS, no group comparisons were significant at $p < 0.10$.

Figure 2. CIRS-G-13 Total Score by Cognitive Status in Persons with CDS = 0
CIRS-G-13 scores (mean $\pm$ sd) were compared across cognitive groups by ANCOVA, adjusting for age and education ($F = 15.6$ [df 2, 234], $p < 0.001$).

Table 1

Subject Characteristics

	Normal	CIND ^o	Demented	F (df)	p
	N= 250	N= 103	N=266		
Age (years)	71.6 (8.3)	74.7 (8.5)	78.2 (8.9)	37.1 (2, 616)	<.0001
Gender(% female)	68.0	69.5	68.5	0.04 (2, 616)	0.96
Education (years)	12.1 (4.7)	8.9 (5.3)	8.7 (7.4)	20.6 (2, 616)	<.0001
Total CDS [*]	2.0 (2.3)	2.5 (2.5)	2.0 (2.3)	1.7 (2, 616)	0.19
CIRS-G-13 Total [†]	7.7 (3.7)	10.2 (4.6)	11.0 (4.6)	40.5 (2, 616)	<.0001
CIRS-G-13 Severity [‡]	1.5 (.35)	1.7 (.32)	1.9 (.31)	20.3 (2, 616)	<.0001
CIRS-G-13 CM2 [§]	2.2 (1.6)	3.2 (1.9)	3.7 (1.9)	42.8 (2, 616)	<.0001

All values except gender are means (SD). All comparisons by ANOVA.

^o CIND – Cognitively impaired, not demented

^{*} CDS – Chronic Disease Score

[†] CIRS-G-13 Total – Cumulative Illness Rating Scale for Geriatrics, 13 items (omitting neuropsychiatric disorders), sum of organ system scores

[‡] CIRS-G-13 Severity = mean of individual organ system summary scores

[§] CM2– number of chronic conditions scored ≥ 2 (moderate, severe, extremely severe)