Multimorbidity is Associated With Better Quality of Care Among Vulnerable Elders

Lillian C. Min, MD, MSHS, Neil S. Wenger, MD,*† Constance Fung, MD, MSHS,*†‡ John T. Chang, MD, MPH,*§ David A. Ganz, MD, MPH,*‡§ Takahiro Higashi, MD, PhD,¶ Caren J. Kamberg, MSPH,† Catherine H. MacLean, MD, PhD,*†‡ Carol P. Roth, RN, MPH,† David H. Solomon, MD,† Roy T. Young, MD,* and David B. Reuben, MD**

Background: Older patients with multiple chronic conditions may be at higher risk of receiving poorer overall quality of care compared with those with single or no chronic conditions. Possible reasons include competing guidelines for individual conditions, burden of numerous recommendations, and difficulty implementing treatments for multiple conditions.

Objectives: We sought to determine whether coexisting combinations of 8 common chronic conditions (hypertension, coronary artery disease, chronic obstructive pulmonary disease, osteoarthritis, diabetes mellitus, depression, osteoporosis, and having atrial fibrillation or congestive heart failure) are associated with overall quality of care among vulnerable older patients.

Materials and Methods: Using an observational cohort study, we enrolled 372 community-dwelling persons 65 years of age or older who were at increased risk for death or functional decline within 2 years. We included (1) a comprehensive measure (% of quality indicators satisfied) of quality of medical and geriatric care that accounted for patient preference and appropriateness in light of limited life expectancy and advanced dementia, and (2) a measure of multimorbidity, either as a simple count of conditions or as a combination of specific conditions.

Results: Multimorbidity was associated with greaer overall quality scores: mean proportion of quality indicators satisfied increased from 47% for elders with none of the prespecified conditions to 59% for those with 5 or 6 conditions ($P < 0.0001$), after controlling for number of office visits. Patients with greater multimorbidity also received care that was better than would be expected based on the specific set of quality indicators they triggered.

Conclusions: Among older persons at increased risk of death or functional decline, multimorbidity results in better, rather than worse, quality of care.

Key Words: multimorbidity, comorbidity, vulnerable elders, quality of care, quality indicators

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As a result of demographic trends and improved medical care, the number of individuals surviving to old age with multiple coexisting chronic conditions (ie, multimorbidity) is increasing. One-third of Medicare beneficiaries in the 65- to 69-year-old age group and more than one-half of those 85 years or older group are estimated to have 3 or more chronic medical conditions.[1] Multimorbidity has been associated with increased health care utilization,[1,2] mortality,[2–4] poorer health-related quality of life,[5–7] and disability.[8] It has also become a concern among advocates of health care quality and safety for older patients.[9,10] The results of several studies have suggested that having multiple morbidities results in poorer quality of care as the result of competing demands for physician attention,[11,12] multiple overlapping guidelines,[10] and increased risk of adverse drug events.[13]

Two recent articles discussed the implications of clinical guidelines for the delivery of high-quality care to older individuals with complex conditions. In a review of major clinical guidelines, Boyd et al[9] argued for cautious implementation of guidelines for older individuals with multiple chronic conditions. Application of available major guidelines to an illustrative case of a woman with 5 conditions (hypertension, chronic obstructive pulmonary disease, diabetes, osteoarthritis, and osteoporosis) resulted in the theoretical need for multiple daily mediations, complex instructions, and monthly medication costs exceeding $400. Tinetti et al[10] argued that a hypothetical older woman with hypertension, coronary artery disease, depression, diabetes, and osteoporo-

From the *David Geffen School of Medicine at UCLA, Los Angeles, California; †RAND Health, Santa Monica, California; ‡Veterans Affairs Greater Los Angeles Health Care System; §UCLA Specialty Training and Advanced Research (STAR) Program; and ¶Department of Epidemiology and Healthcare Research, Kyoto University, Kyoto, Japan.

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Reprints: Lillian Min, MD, MSHS, Department of Medicine-Geriatrics, University of California, Los Angeles, 10945 Le Conte Avenue, Suite 2339 Box 951687, Los Angeles, CA 90095-1687. E-mail: lmin@mednet.ucla.edu.

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sis would need to take as many as 11 medications, with the potential for decreasing marginal benefit and increasing adverse drug event risk. Both articles concluded that enforcing quality measurement for older complex patients may result in unintended harm unless future measures consider older patients' chronic conditions, life expectancy, and preferences. However, measurement of quality of care may be important for older persons who are at increased risk for death or functional decline because the quality of care these vulnerable elders receive was shown to be poor in 1 study[14] and vulnerable elders who receive better quality of care may benefit from improved survival.[15]

To date, there has been little research on the relationship of multimorbidity and quality of care. Published studies, based on administrative data, have demonstrated inconsistent results. Some indicate that multimorbidity is associated with poorer care,[16–18] but others suggest that it may be associated with better quality of care.[19–21] In a prior analysis, we examined the relationship of patient characteristics with overall quality of care among vulnerable (at increased risk for death and functional decline) older persons enrolled in the Assessing the Care of Vulnerable Elders (ACOVE) study.[22] Contrary to our expectations, we found that having more chronic conditions was associated with better overall quality of care,[20] whereas other variables such as age, gender, and higher vulnerability scores were not significant predictors.

Building on these findings, we examined in this study the relations between a set of prevalent chronic conditions and overall quality of care among vulnerable older patients. We applied ACOVE quality of care data to hypothetical case examples similar to those described by Boyd and Tinetti.[9,10] In addition, we hypothesized that patients with greater multimorbidity would have a higher number of office visits, thereby increasing opportunities for clinicians to provide recommended care. Therefore, we tested whether office visit utilization affected the relationship between number of conditions and overall quality score. We also examined whether those with multiple conditions were eligible for quality indicators that were more easily passed by the study population, which might inappropriately inflate quality scores.

METHODS

We analyzed data from the ACOVE study,[14,23] which measured 22 areas of medical and geriatric care using 207 quality indicators (QIs).[24] These quality indicators measure whether health care processes (eg, prescribing medications or ordering tests) are performed, rather than the outcome of the health care (eg, blood pressure control, mortality rate). The QIs were based on a systematic review of evidence to support each QI's role in preserving outcomes (functional status, mortality) among older vulnerable elders, followed by expert panel selection.[14,23] The 22 areas of care included condition-specific care (depression, dementia, falls/mobility problems, hearing loss, congestive heart failure, hypertension, ischemic heart disease, osteoarthritis, osteoporosis, pneumonia, pressure ulcer, stroke and atrial fibrillation, urinary incontinence) as well as general categories of care (continuity and coordination, end-of-life, malnutrition, medication management, pain management, screening and prevention, and vision care) that were not conditional on specific conditions.[14]

The 372 community-dwelling study participants were randomly selected from among the older (aged ≥65) enrollees of 2 managed-care organizations (MCOs). The MCOs were located in the northeastern and southwestern United States, had more than 20,000 older enrollees, and contracted with networks of providers. Participants were screened using the Vulnerable Elders Survey (VES-13). Elders with VES-13 scores of ≥3 are at 4.2 times increased 2-year risk of functional decline and death compared with those with scores of ≤2.[22] Forty-three percent of those screened for the study were identified as vulnerable; 88% of these consented to be in the study. Care was provided by 589 providers, 216 of which were primary care physicians.[14] Of the primary care physicians, most cared for only 1 or 2 patients in our sample, but 31 cared for 3–8 patients.

Participants qualified for (or "triggered") QIs based on their medical conditions (eg, IF a vulnerable elder has diabetes, THEN aspirin should be recommended) but all patients also qualified for a smaller subset of screening and prevention measures (eg, ALL vulnerable elders should screened for alcohol use). A QI was "passed" if the care process was fulfilled based on a 13-month medical record abstraction and patient interview. As reported previously, the subjects qualified for a total of 10,711 QIs and passed 55% of them. The subjects were eligible for a mean of 29 (range, 9–61) quality indicators.[14] The care was assessed retrospectively, and at the time the health care was delivered, the clinicians did not know they would be studied.

If the medical record indicated that the care process was not needed or that it conflicted with patient preference (eg, the patient desired to forgo all surgery or hospitalization), then the QI was excluded from scoring. Those with poor prognosis (≤6 months life expectancy, enrolled in hospice care, or described in the medical record as "terminally ill") or advanced dementia were not eligible for QIs that were predetermined to be clinically inappropriate due to excessive burden or lack of short-term benefit. Thirty-nine elders qualified for an exclusion of a portion of their QIs (a mean of 5% of the QIs they triggered) based on these criteria.[25]

Fifteen specific chronic conditions were identified during the medical record abstraction. These conditions were preselected for their effect on health and function among older individuals and included: dementia,[26,27] depression,[28–31] diabetes mellitus,[29,32] hearing loss,[33,34] heart failure,[31,35] hypertension,[29,36,37] coronary artery disease,[29,31] osteoarthritis,[31,38] osteoporosis,[29,39] stroke,[29,31] atrial fibrillation,[40,41] urinary incontinence,[30,42] chronic renal failure,[43] chronic obstructive lung disease,[31,44] and pressure ulcers.[45]

Measures

From these conditions, we selected a subset of conditions for this analysis based upon (1) their inclusion in the Boyd[9] or Tinetti[10] articles on national guidelines affecting elders with multimorbidity, and (2) their prevalence (>5% of the US population aged ≥65 years old in the 2001–2 National Health Interview Survey [NHIS][46] and >10% of our study population) to ensure adequate sample size for our analysis of

condition combinations. The following 9 conditions were selected: hypertension (HTN), coronary artery disease (CAD), chronic obstructive pulmonary disease (COPD), osteoarthritis (OA), diabetes mellitus (DM), depression, osteoporosis (OP), atrial fibrillation (AF), and congestive heart failure (CHF). The first 7 conditions were highlighted in the illustrative case studies in either Boyd et al[9] or Tinetti et al,[10] and the first 5 were prevalent self-reported chronic medical conditions among older Americans.[46] The NHIS also reported that 31% of the older US population suffers from all types of heart conditions, including AF and CHF. Because of the overlap between the 2 conditions in the sample (23 patients had both CHF and AF, 34 had CHF but not AF, 25 had AF but not CHF), common pathophysiologic pathways,[47] and to ensure that there would be adequate numbers for our analysis, individuals were considered a priori for a combined AF and CHF condition category if they had either disease. This resulted in 8 conditions considered for the analysis.

The observed overall quality of care score was calculated as the number of QIs passed divided by the number of QIs for which the individual was eligible, expressed as a percentage. We applied the exclusion criteria (poor prognosis, advanced dementia, and patient preferences for no hospitalization or surgery) to quality scores in the main analysis but also calculated quality scores using all triggered QIs for sensitivity analyses. The number of office visits (which included visits to generalist and specialist physicians, psychologists, and optometrists) were determined from administrative data.

Because QIs for the various conditions varied substantially with respect to their pass rates and some patients may have triggered more "difficult" QI patterns based on their conditions, we felt that our analysis should account for level of difficulty based on the pattern of QIs they triggered.[14] Therefore, we calculated an observed-minus-expected (O − E) quality score for each patient representing how much better or worse the observed score was in comparison to a hypothetical average quality score. To determine expected quality scores, we first computed the population-based pass rate for each QI. We then calculated the average of these population-based pass rates for each patient given their set of triggered QIs (ie, 2 patients triggering identical QIs would therefore have identical expected quality scores). To obtain the O − E score, the expected quality score was subtracted from the observed quality score and expressed as a difference in percentage points. Patients with negative scores had observed quality scores that were less than expected; patients with positive scores had observed quality scores that were greater than expected.

Last, we also considered the quality of care received that was specific to the care of the 8 selected conditions (rather than the overall quality of care): hypertension (8 QIs), CAD (13 QIs), osteoarthritis (14 QIs), diabetes (10 QIs), CHF or AF (17 QIs), depression (17 QIs), and osteoporosis (10 QIs). There were no QIs in this indicator set specific to the care of COPD. For the patients with each of the 7 conditions, we calculated a condition-specific score as a mean of the QI scores for the specific QIs (ie, the mean score of the 10 diabetes QIs for each of the diabetic patients). We also calculated the percent of each subjects' total triggered QIs that were triggered within each specific condition. For example, if a patient with hypertension triggered 30 QIs, 3 of which were specific to the care of hypertension, then that patients' percent hypertension-specific QIs triggered would be 3 of 30 = 10%.

Analysis

First, we performed a simple count of the 8 conditions for each participant. Because the relationship between the number of conditions and quality may not be linear, we considered count of conditions in 2 ways. The first method was to assume a linear relationship between the number of conditions and quality. This number had a possible range from 0 to 5 because no participants had 7 or 8 of the conditions considered and because we combined participants with 5 (n = 17) and 6 conditions (n = 4) because of their small cell size. In the second method, we treated the count of conditions as a categorical variable. Categories were represented by 6 indicator variables, from no conditions up to 5 or more conditions.

The 8 conditions were combined into all possible unique pairs (28) and triplets (56), and indicator variables were created for each combination. Mean overall quality and mean condition-specific scores were calculated for individuals with each of 8 chronic conditions, the 28 specific condition pairs, 56 condition triplets, and 3 common condition quadruplets.

Analysis of variance was used to evaluate the relationship between overall quality and the number of conditions. Linear regression was performed using the number of conditions first as a linear variable, then as separate indicator variables, controlling for number of office visits. Age, gender, and low income (<$15K annually) were tested in a preliminary model. We adjusted all regressions for clustering by primary care doctor. To obtain confidence intervals around predicted quality scores associated with number of conditions, bootstrapping (1000 repetitions, percentile method)[48] was performed on the latter regression model.

Last, "case illustrations" of up to 4 specific condition combinations were developed to demonstrate how "adding" comorbid conditions affects overall quality of care. On the basis of the most prevalent condition triplets (ie, at least 15 elders in our sample had all 3 conditions), we constructed condition quadruplets that would be likely to also be prevalent in our sample. Three quadruplet combinations had 9 or more elders. Then, within each of these quadruplets, we considered elders according to the conditions combined sequentially: (1) none of the 4 conditions, (2) only 1 specific condition (and none of the other conditions), (3) the first specific condition plus 1 additional condition (but none of the others), (4) the 2 conditions plus another condition (but not the last condition), and (5) those who had all 4 conditions. The order of conditions was determined by their prevalence in the population, from most to least prevalent. The overall quality scores were calculated for each of these sequentially increasing combinations, and analysis of variance was performed to test their relationship with overall quality.

The sensitivity of our results to QI difficulty and our exclusion criteria were performed. O − E scores were calcu-

lated and tested for their relationship with both the simple count of conditions and for the 3 case illustrations of specific conditions. To test sensitivity to our exclusion criteria, we first modeled the effect of multimorbidity on overall quality scores (with exclusions) using an additional control variable for each participant's number of excluded QIs. Second, we evaluated the relationship between the overall quality scores before exclusions and multimorbidity. All analyses were performed using Stata Statistical Software, Release 8.0 (College Station, TX, 2003).

RESULTS

The mean age of the patients in the study was 81 years, and nearly two-thirds were women. The prevalence of the 8 conditions ranged from 12% for osteoporosis to 61% for hypertension (Table 1). Both the observed overall quality score (mean 54%; range, 27–79%) and O − E scores (mean −1%; range, −28% to 25%) were normally distributed. At the patient level, when quality scores were examined according to presence of each of the 8 conditions, there was a wide range in mean condition-specific quality scores (from 30% for depression to 84% for hypertension), but not in mean overall quality scores (55–57%). Only a fraction of the patients' total QIs pertained to any 1 of the 8 examined conditions (2% for hypertension to 14% for DM; Table 1).

The mean number of office visits during the 13-month study was 8.7, (SD = 5.7; range, 0–34). The correlation coefficient (r) between number of office visits and number of conditions was 0.31 ($P < 0.0001$); between number of office visits and overall quality scores was 0.20 ($P = 0.0001$).

Hypertension, CAD, DM, and COPD commonly occurred in combination with other conditions. Mean overall quality scores were generally higher in patients with specific combinations of conditions than in the total sample (26 of 28 pairs of conditions and 24 of 25 triplets had mean overall quality scores higher than 55%, the mean overall quality score in the total sample; see the Appendix).

Only 8.3% of the sample had none of the 8 conditions, and 62% percent of the sample had 2 or more of the 8 selected conditions. (Table 2) Multimorbidity was associated with

TABLE 1. Condition-Specific and Overall Quality Scores

Condition	No. Elders* (Prevalence, n = 372; %)	Mean Condition-Specific Quality Score (%)†	Mean % of Triggered QI That Were Condition-Specific (%)‡	Mean Overall Quality Score (%)§
Hypertension	228 (61)	84.1	1.8	56.3
CAD	116 (31)	51.8	4.9	57.1
COPD	94 (25)	n/a	0	56.3
OA	90 (24)	42.6	5.6	54.9
DM	88 (24)	57.6	14.1	56.2
CHF or AF	82 (22)	78.2	4.4	58.5
Depression	61 (16)	30.0	3.0	56.5
OP	45 (12)	45.4	10.7	54.7

*The total number (or percents) in these columns are greater than 372 (or 100%) because participants could have more than 1 condition.

†Mean quality score of QIs within the indicated conditions, among patients with the indicated condition.

‡Percent condition-specific triggered QIs = number of condition-specific QIs divided by total QIs triggered, calculated only for those patients with the indicated condition. If a patient with DM triggered 30 QIs, 3 of which were specific to the care of DM, then that patient's percent hypertension-specific QIs triggered would be 3 of 30 = 10%.

§Quality Score = no. of QIs passed/no. of QIs eligible, expressed as a percent. Overall quality scores were based on QIs covering 22 areas of geriatric and general medical care: continuity and coordination of care, dementia, depression, DM, end of life, falls/mobility problems, hearing loss, CHF, hospital care, HTN, CAD, malnutrition, medication management, OA, OP, pain management, pneumonia, pressure ulcer, screening & prevention, stroke and AF, urinary incontinence, vision care.

TABLE 2. Mean Overall Quality Scores and Expected Quality Scores by Number of Selected Conditions*

No. Conditions	Prevalence (No. Elders)	Mean No. Eligible QIs per Elder	Mean Observed Overall Quality (%)†	Expected Overall Quality (%)‡	Difference (O − E, %)§
0	8.33% (n = 31)	22	46.7	54.2	−7.5
1	29.8% (n = 111)	25	52.7	54.7	−2.0
2	23.9% (n = 89)	28	53.8	55.5	−1.7
3	19.9% (n = 74)	32	56.7	55.6	1.2
4	12.4% (n = 46)	36	59.1	56.0	3.1
5 or 6 conditions	5.6% (n = 21)	38	59.4	56.0	3.4
P value for trend within column			$P < 0.0001$	$P = 0.13$	$P < 0.0001$

*Conditions considered included HTN, CAD, DM, CHF or AF, COPD, depression, OA, and OP.

†Mean observed overall quality = no. of QIs passed divided by the no. of QIs eligible, expressed as a percent. Participants were eligible for QIs covering 22 areas of geriatric and general medical care: continuity and coordination of care, dementia, depression, DM, end of life, falls/mobility problems, hearing loss, CHF, hospital care, HTN, CAD, malnutrition, medication management, OA, OP, pain management, pneumonia, pressure ulcer, screening and prevention, stroke nd AF, urinary incontinence, vision care.

‡Expected overall quality = expected score if the mean pass rate were achieved for eligible QIs.

§Difference (O − E) = difference between the observed and expected mean overall quality scores.

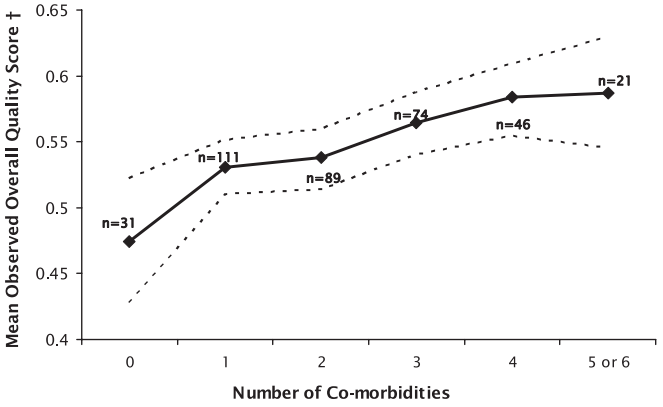

FIGURE 1. Overall quality of care increases with a greater number of comorbid conditions (n = 372).

*The simple count of 8 conditions were considered: hypertension, coronary artery disease, congestive heart failure or atrial fibrillation, chronic obstructive pulmonary disease, depression, osteoarthritis, or osteoporosis.

†Predicted quality scores are obtained by linear regression on number of conditions (tested as 6 separate indicator variables), adjusted for number of office visits. 95% confidence intervals were derived by bootstrapping, percentile method for 1000 repetitions, and adjusted for clustering by primary care physician.

higher overall quality scores (F = 6.89, $P < 0.0001$), from mean of 47% of QIs passed among those with no conditions to 59% among those with 5 or 6 of the conditions (Fig. 1). O − E quality scores also increased with the number of conditions, increasing from −7.5% for those with no conditions to 3.4% for those with 5 or 6 conditions (F = 5.79, $P <$ 0.0001).

The linear regression model predicting quality scores that considered number of conditions as a linear variable (adjusting for number office visits) yielded a β-coefficient of 020 ($P =<.001$), which means that for every additional condition, the overall quality score was expected to increase by 2% points. Age, gender, and income did not affect the β-coefficient of multimorbidity. Each additional office visit increased the quality score by only 0.23% points ($\beta =$ 0.0023, $P = 0.017$). When we removed the number of office visits from the model, the unadjusted coefficient for number of conditions was 023 ($P < 0.001$). When we modeled the O − E score as a linear function of number of conditions (adjusted for number of office visits), the difference between observed and expected scores increased by 1.6% points with each additional condition ($P < 0.0001$). We used the regression model that considered number of conditions as 6 separate indicator variables (controlling for number of office visits) to obtain the predicted overall quality and bootstrapped 95% confidence intervals (Fig. 1). When we performed a regression of O − E score on the 6 separate indicator variables (controlling for number of office visits), the O − E scores increased from −5.1% points for no conditions to 4.5% points for those with 5 or 6 conditions.

The 3 "case" illustrations derived from the more prevalent quad-morbid condition combinations consistently demonstrated the increase in quality with multimorbidity. The top 3 combinations of 4 conditions were: (1) hypertension, CAD, DM, and having either CHF or AF, (2) hypertension, CAD, COPD, and DM, and (3) hypertension, CAD, COPD, and having either CHF or AF. For each case, we computed the quality for all patients who had just the first condition, then patients with the first 2 conditions only, and so on. In each case, patients with greater number of conditions received higher quality care (Table 3). The analysis of variance of increasing overall quality across the sequentially ordered categories was significant in all 3 examples. O − E quality also increased with the ordered categories consistently across the 3 cases.

Of the 39 patients eligible for exclusions, 33 patients triggered any of the excluded indicators. The 33 patients with excluded QIs had a mean of 2.2 conditions, versus 2.1 for those who were not eligible for exclusions ($P = 0.78$). Their mean overall quality score was 55.8% before exclusions and 54.9% after exclusions ($P = 0.001$ by paired t test). In the multivariable regression of overall quality (after exclusions applied) the effect of multimorbidity was unchanged ($\beta =$ 0.020, $P < 0.0001$) from the original analysis and the β-coefficient for number of exclusions was 0015 ($P = 0.24$). The effect of multimorbidity was also unchanged when we modeled overall quality (before exclusions).

DISCUSSION

In this sample of community-dwelling elders at increased risk of death or functional decline, we found that multimorbidity was associated with higher quality of care using a quality measure that considers patient preferences and limited life expectancy. This finding held true whether we looked at simple counts of conditions or specific conditions considered sequentially in combination. Our results were independent of the number of office visits and were robust when we used O − E scores, which accounted for differences in individuals' eligibility for indicators of varying difficulty.

Previous studies have focused on the effect of comorbid conditions on index conditions of interest or have been limited by the use of a small number of quality measures that could be derived from administrative databases.[2,16,17,19,21] Using a comprehensive set of quality indicators evaluated by medical record review, patient interview, and administrative data, we have not been able to confirm prior concerns[9–13,18] that multimorbidity is associated with poorer care. Rather, the ACOVE study has shown that greater number of conditions, whether using a simple count of conditions[20] or specific combinations of conditions, is associated with higher quality of care.

There are several explanations why the ACOVE study may have found multimorbidity to be associated with greater quality of care. First, there may be greater perceived need to provide better care for older persons with multimorbidity. For example, physicians may be more likely to treat hypertension for a patient who had diabetes compared with a patient who does not because of the additional importance of blood pressure control in preserving renal function in diabetic patients.[49] The relatively smaller effect of number of office visits on the multimorbidity-quality relationship suggests that it is more likely to be clinical decision-making than pure

TABLE 3. Three Examples of Increasing Overall Quality in Response to Specific Conditions Added in Combination

Example 1 Conditions Present								
HTN	**CAD**	**DM**	**Afib/CHF**	**Prevalence, (n)**	**Mean No. Eligible QIs**	**Observed Overall Quality (%)***	**Expected Overall Quality (%)†**	**Difference (O − E; %)‡**
	Any			80% (n = 296)	30	55.4	55.3	−0.3
Absent	Absent	Absent	Absent	32% (n = 76)	25	50.6	53.7	−3.1
Present	Absent	Absent	Absent	44% (n = 104)	26	54.1	55.1	−1.0
Present	**Present**	Absent	Absent	10% (n = 24)	28	56.7	54.2	2.5
Present	**Present**	**Present**	Absent	9% (n = 22)	32	58.6	55.0	3.6
Present	**Present**	**Present**	**Present**	5% (n = 11)	39	62.4	58.6	3.8
P value for one-way ANOVA performed on scores within column:						$P = 0.0015$	$P = 0.0003$	$P = 0.0256$
Example 2 Conditions Present								
HTN	**CAD**	**COPD**	**DM**	**Prevalence, (n)**	**Mean No. Eligible QIs**	**Observed Overall Quality (%)***	**Expected Overall Quality (%)†**	**Difference (O − E; %)‡**
	Any			83% (n = 309)	30	55.6	55.6	−0.1
Absent	Absent	Absent	Absent	17% (n = 64)	25	49.1	53.5	−4.4
Present	Absent	Absent	Absent	26% (n = 95)	26	54.3	54.8	−0.5
Present	**Present**	Absent	Absent	9% (n = 35)	31	58.1	54.9	3.2
Present	**Present**	**Present**	Absent	3% (n = 11)	29	56.0	53.6	2.3
Present	**Present**	**Present**	**Present**	3% (n = 11)	37	59.0	56.9	2.1
P value for one-way ANOVA performed on scores within column:						$P = 0.0007$	$P = 0.0183$	$P = 0.0081$
Example 3 Conditions Present								
HTN	**CAD**	**COPD**	**Afib/CHF**	**Prevalence, (n)**	**Mean No. Eligible QIs**	**Observed Overall Quality (%)***	**Expected Overall Quality (%)†**	**Difference (O − E; %)‡**
	Any			81% (n = 300)	29	55.8	55.6	0.2
Absent	Absent	Absent	Absent	19% (n = 72)	26	48.5	53.7	−5.2
Present	Absent	Absent	Absent	27% (n = 101)	27	54.1	55.3	−1.1
Present	**Present**	Absent	Absent	7% (n = 27)	34	57.5	55.1	2.4
Present	**Present**	**Present**	Absent	3% (n = 13)	33	56.5	54.4	2.1
Present	**Present**	**Present**	**Present**	2% (n = 9)	33	58.9	56.5	2.3
P value for one-way ANOVA performed on scores within column:						$P = 0.0003$	$P = 0.0177$	$P = 0.005$

*Observed overall quality = no. of QIs passed divided by the no. of QIs eligible, expressed as a percent. Participants were eligible for QIs covering 22 areas of geriatric and general medical care: continuity and coordination of care, dementia, depression, DM, end of life, falls/mobility problems, hearing loss, CHF, hospital care, HTN, CAD, malnutrition, medication management, OA, OP, pain management, pneumonia, pressure ulcer, screening and prevention, stroke & AF, urinary incontinence, vision care.

†Expected overall quality = expected score if the mean pass rate were achieved for eligible QIs.

‡Difference (O − E) = difference between the observed and expected mean overall quality scores.

exposure that is responsible for this association. Alternatively, we considered that the rise in quality scores with multimorbidity could reflect double credit for similar care processes recommended for 2 or more conditions selected for the analysis (eg, recommending aspirin for CAD and DM). However, potentially double-counted QIs occurred in only 0.2% of the QIs triggered in this study and did not affect the relationship between multimorbidity and quality. Last, physicians who adhere to clinical guidelines may be better at managing patients with multiple medical conditions. We could not investigate this explanation because most physicians only had 1 or 2 patients in our study.

This study responds to some of the concerns about quality measurement and clinical guidelines that have been recently proposed by Boyd[9] and Tinetti.[10] The measurement of quality delivered to older patients with multimorbidity was feasible when we used a comprehensive measurement system and considered elders' preferences, life expectancy and overall prognosis. Two preferences for limiting health care (not to hospitalize or perform surgery) and advanced functional dependency due to dementia or short life expectancy were used as criteria for excluding the scoring of selected QIs.[25] We acknowledge that these exclusions could not completely account for the individualized preferences and complexity of medical decisionmaking for elders with multimorbidity. Also, if care had been appropriately withheld for an elder that qualified for an excluded QI, our neutral scoring method did not award credit to the overall quality score. Last, our finding that quality of care as measured by ACOVE indicators increased with number of conditions does not directly address their concerns about risk of adverse drug interactions, drug costs, or whether patients with many conditions felt overburdened by multiple recommendations by their physicians. However, in light of our prior finding that better overall

quality is associated with improved survival,[15] our results suggest that the effect of multimorbidity on care processes may not be as harmful as one would expect.

Our study was not able to address several other issues. Because the clinicians were unaware that their quality was measured at the time the care was delivered, our study was not able to address whether this relationship would persist if incentives were provided for higher quality of care. In addition, our study sample was selected for their intermediate-to-high risk of functional decline and death (determined by the VES-13[22]), and therefore our results may not be generalizable to a healthier or frailer older population. In particular, further study is needed before applying these findings to those who have severe functional impairment or reside in nursing homes. Third, the sample was drawn from MCOs, and the care of these conditions may differ in fee-for-service patient populations. Fourth, the highest-quality scores for the highest categories of multimorbidity in this study still fell (on average) less than 60% of recommended care. Care improvement is needed at all levels of multimorbidity. Fifth, our sample size limited our ability to perform a wider number of tests, eg, using a greater variety of condition combinations, as well as whether or not the quality of care for specific index conditions also rose with higher numbers of conditions. Finally, our measure of overall quality reflects a broad range of technical quality but does not include nontechnical aspects of quality, such as patient rating of interpersonal skills or overall patient satisfaction. Aspects of nontechnical care have been found to be unrelated to technical quality[50] and therefore may have a different relationship with multimorbidity.

In conclusion, we found that provision of higher quality of care for vulnerable elders is feasible with multiple chronic conditions. Quality improvement initiatives aimed at the care of vulnerable older adults can be based on quality measures that take into account life expectancy and patient preferences.

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APPENDIX. Comorbid Condition Pairs and Triplets: Prevalence, and Overall Quality Scores for Elders With Specific Combinations

Pairs of Conditions								No. Elders With at Least Both Conditions*	Percent With at Least Both Conditions (n = 372)*	Mean Overall Quality Score† for Those With at Least Both Conditions*
HTN	CAD	CHF or AF	OA	DM	Dep	OP	COPD			
x	x							73	20%	58%
x				x				62	17%	59%
x			x					60	16%	56%
x							x	58	16%	58%
x		x						57	15%	60%
	x	x						48	13%	59%
x					x			44	12%	57%
	x			x				37	10%	59%
	x						x	36	10%	56%
				x			x	27	7%	56%
		x					x	27	7%	60%
x						x		27	7%	59%
	x		x					26	7%	61%
		x		x				25	7%	62%
			x	x				22	6%	58%
	x				x			21	6%	56%
					x		x	21	6%	57%
			x			x		18	5%	52%
			x		x			17	5%	60%
						x	x	16	4%	58%
		x	x					14	4%	59%
				x	x			14	4%	58%
			x				x	13	3%	58%
		x			x			13	3%	56%
					x	x		11	3%	54%
	x					x		11	3%	61%
		x				x		10	3%	59%
				x		x		9	2%	55%

(*Continued*)

APPENDIX. (*Continued*)

Combinations of 3 Conditions‡								No. Elders With All 3 Conditions*	Percent With All 3 Conditions (n = 372)*	Overall Quality Score† for Elders With All 3 Conditions
HTN	CAD	CHF or AF	OA	DM	Dep	OP	COPD			
x	x	x						33	9%	60%
x	x			x				27	7%	60%
x	x						x	22	6%	57%
x				x			x	22	6%	61%
x		x		x				19	5%	63%
	x	x					x	18	5%	57%
x	x		x					17	5%	61%
x			x	x				16	4%	59%
x					x		x	16	4%	57%
	x	x		x				16	4%	61%
x	x				x			15	4%	58%
x		x						15	4%	62%
	x			x			x	15	4%	58%
x			x		x			14	4%	60%
x			x			x		12	3%	52%
	x	x	x					12	3%	59%
x				x	x			11	3%	58%
	x				x		x	11	3%	56%
	x		x	x				11	3%	63%
x		x	x					10	3%	57%
x		x			x			10	3%	58%
x						x	x	10	3%	60%
x			x				x	9	2%	57%
	x			x	x			9	2%	58%
		x		x			x	9	2%	61%

*The total number (or percents) in these columns are greater than 372 (or 100%) because participants could have more than 1 comorbidity pair present.

†Mean Overall Quality Score = no. of QIs passed divided by no. of QIs eligible, expressed as a proportion or percent. Participants were eligible for QIs which covered 22 areas of geriatric and general medical care: continuity & coordination of care, dementia, depression, DM, end of life, falls/mobility problems, hearing loss, CHF, hospital care, HTN, CAD, malnutrition, medication management, OA, OP, pain management, pneumonia, pressure ulcer, screening & prevention, stroke & AF, urinary incontinence, vision care.

‡Only n ≥ 9 elders are displayed.

Dep indicates depression.