Change in Comorbidity Prevalence with Advancing Age Among Persons with Heart Failure

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BACKGROUND: Comorbidity—a condition that co-exists with a primary illness—is common among older persons with heart failure and can complicate the overall management of this population.

OBJECTIVES: To determine the relationship between advancing age and the prevalence and patterns of comorbidity among older persons with heart failure.

DESIGN: Retrospective longitudinal cohort study

PARTICIPANTS: A total of 201,130 Medicare beneficiaries with heart failure stratified into three age strata in 2001: 66–75, 76–85, and 86+ years, and followed over 5 years.

MEASUREMENTS: (1) Prevalence of 19 conditions as identified by the Chronic Conditions Warehouse from Medicare claims data, characterized as concordant (related to heart failure) or discordant (unrelated to heart failure), and (2) overall comorbidity burden, defined as count of conditions.

RESULTS: The median number of comorbidities rose from four (IQR: 2–5) to five (IQR: 4–7) among the young-old, and from 4 (IQR: 3–6) to 6 (IQR: 5–8) among the middle-old and oldest-old between 2001 and 2006. In 2001, the majority of concordant conditions were more prevalent among the youngest than oldest beneficiaries (e.g., diabetes 46.2% vs 26.9%; kidney disease 21.8% vs 18.4%), while the majority of discordant conditions were more prevalent among the oldest-old than youngest-old beneficiaries (e.g., dementia 39.6% vs 9.9%; hip fracture 9.5% vs 1.9%). Discordant conditions increased in prevalence faster among the oldest than youngest beneficiaries (e.g., dementia 13% points versus 9% points).

CONCLUSION: Among older Medicare beneficiaries with heart failure, there is a higher overall burden of comorbidity and greater prevalence of discordant comorbidity among the oldest old. Comorbidity prevalence increases over time, with discordant comorbidity increasing at the fastest rate among the oldest old. This comorbidity burden highlights the challenge of effectively treating heart failure while simultaneously managing co-existing and unrelated conditions.

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INTRODUCTION

The increase in the prevalence of chronic conditions with advancing age, coupled with a rapidly aging US population, makes comorbidity—a chronic condition that co-exists with a primary illness[1]—a critical public health issue for older persons. This is of particular relevance to older adults with heart failure, as comorbidity in this population increases symptomatology[2], polypharmacy[3], risk of hospital readmissions[4,5], and mortality[6–10]. Moreover, the management of comorbidity, particularly those conditions that are not directly related to heart failure in either pathogenesis or management, can significantly complicate the overall care needed by these patients[3]. A thorough understanding of the prevalence and patterns of comorbidity among the elderly is critical to health care planning and quality improvement efforts.

Population-based data on the prevalence of comorbid conditions among older adults with heart failure have indicated a large burden of comorbidity; for example, Braustein et al. (2003) reported that approximately 72% of Medicare beneficiaries with heart failure have at least five comorbid conditions[9]. These studies have examined older persons as a single cohort[9,11,12], which may obscure important age-dependent differences in disease prevalence. There has been little empiric investigation of changes in comorbidity prevalence as older adults with heart failure survive into very old age. Existing data support two potentially opposing hypotheses regarding the relationship between comorbidity and advancing age. On the one hand, evidence linking certain comorbidities in heart failure to increased mortality[6–10] suggests that persons who survive to very old age with heart failure are less likely to have those comorbidities. On the other hand, the increase in prevalence with advancing age of several chronic diseases unrelated to heart failure, such as dementia[13–16], suggests that older adults with heart failure may accumulate comorbidity as they survive into old age. An existing framework developed by Piette and Kerr (2006) characterizes comorbid conditions as either concordant with the primary disease—related in pathophysiology or management and on the same treatment pathway—or discor-

dant with the primary disease—unrelated in pathophysiology or management and not likely to be part of the same treatment plan[17,18]. This framework helps to unify the two hypotheses by suggesting that the comorbidity profiles of older adults with heart failure may change with increasing age such that they have a lower prevalence of concordant conditions but a higher prevalence of discordant conditions. In contrast to prior work that characterized comorbidity as cardiac or non-cardiac[9], the use of this framework may provide additional insight into the care of older persons with multiple conditions, because comorbidites are characterized in terms of whether they are likely to be the focus of the same treatment plan.

The purpose of this study was to determine the relationship between aging and comorbidity among a population-based sample of older adults (>65 years) with heart failure by (1) examining the cross-sectional prevalence of a broad range of both concordant and discordant comorbid conditions across age groups, and (2) determining changes in the prevalence of comorbid conditions over time.

METHODS

We conducted a retrospective longitudinal cohort study of Medicare beneficiaries with congestive heart failure. Participants were selected from the Center for Medicare and Medicaid Services (CMS) Chronic Conditions Warehouse (CCW), a 5% random sample of Medicare beneficiaries providing beneficiary, assessment, and claims data across the continuum of care. The CCW includes 21 chronic condition variables indicating the presence of a condition as defined by evidence-based algorithms that specify (1) a minimum number of diagnoses/procedure codes, (2) occurring within a specific time frame (either 1, 2, or 3 years), and (3) within certain care settings. For example, the variable indicating the presence of congestive heart failure is derived from the occurrence of at least one of the following International Classification of Diseases, Ninth revision (ICD-9) codes: 398.91, 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 404.03, 404.13, 404.9, or 428.xx, occurring within a 2-year period in either the inpatient or outpatient setting.

Study Population

The initial study cohort included all living CCW beneficiaries who were identified as having heart failure as of January 1, 2001 (n=241, 254). From this cohort, we excluded (1) all beneficiaries age≤65 years (n=20,938) to ensure that all included beneficiaries were at least 65 years of age during the lookback period; (2) all beneficiaries who received care outside traditional fee-for-service (FFS) Medicare at any point between January 1, 2000, and December 31, 2006 (n=18,852), and (3) any beneficiaries with missing data during the study period (n =334). The final study sample included 201,130 Medicare beneficiaries with heart failure.

Chronic Condition Measures

We examined 19 additional chronic condition variables, which we characterized as either concordant or discordant comorbidities. Concordant comorbidities included acute myocardial infarction (AMI), atrial fibrillation (AFIB), chronic kidney disease (CKD), diabetes, ischemic heart disease (IHD), and stroke/TIA. Discordant comorbidities included Alzheimer's disease and related disorders or senile dementia (dementia), cataracts, depression, glaucoma, hip/pelvic fracture, osteoporosis, rheumatoid arthritis/osteoarthritis (arthritis), and cancer (female breast, colorectal, prostate, lung, and endometrial). The characterization of chronic obstructive pulmonary disease was problematic. Although COPD is not pathophysiologically related to heart failure, the two conditions have highly overlapping signs and symptoms, and COPD has been shown to increase mortality risk in heart failure[7]. We therefore characterized COPD as concordant. We considered these conditions to be present from the time they were identified through the data set timeframe. We examined comorbidity both in terms of individual conditions as well as comorbidity burden, defined as a count of conditions.

Analysis

We stratified our study cohort into three subcohorts according to beneficiaries' ages as of January 1, 2001 (young-old: 66–75 years, middle-old: 76–85 years, and oldest-old: 86+ years). We followed these participants through 2006 without replacement for deaths. We used univariate statistics to describe the demographics of the study cohort at the beginning of 2001. We defined comorbidity burden as the total number of comorbid conditions. Because burden was not normally distributed, we used two non-parametric approaches to examine this variable. First, we characterized burden according to age strata in 2001 and 2006 using the median and interquartile range (IQR). Second, we used the Kruskal-Wallis test to determine the significance of the association between comorbidity burden and age strata. We determined the prevalence of each condition at the end of 2001 and 2006 within the three age strata. Prevalence was calculated as the number of beneficiaries who had the specified comorbidity at the end of a year, over the total number of beneficiaries alive at the beginning of that year. We calculated the change in prevalence over time as the difference between the prevalence of a given condition in 2001 and its prevalence in 2006.

RESULTS

Of the 201,130 Medicare beneficiaries in the CCW identified as having heart failure in 2000, the majority were women (60.6%) and white (86.5%),with a median age of 80 years (Table 1). By the end of the study period in 2006, 62.7% of the initial sample had died. Beneficiaries in our study had a high burden of comorbidity, with 40.6% of the sample having five or more chronic conditions in addition to heart failure as of 2001. In the overall cohort, IHD (74.9%) and cataracts (50.9%) were the two most prevalent conditions. Diabetes, COPD, AFIB, and arthritis had a prevalence of 30–40%, while stroke, CKD, dementia, depression, and osteoporosis had a prevalence of 20–25%. Glaucoma was prevalent among 15.1% of the sample, AMI among 8.4%, and hip fracture among 5.1%, while the prevalence of all cancers was less than 5%.

Table 1. Description of Study Cohort at Baseline (2001)

Characteristics	Total sample (n=201,130)
Age, years, median (IQR*)	80 (74–86)
66–75 years, n (%)	59,692 (29.6)
76–85 years, n (%)	87,408 (43.4)
86+ years, n (%)	54,030 (27)
Gender, %	
Female	60.6
Male	39.4
Race/ethnicity %	
White	86.5
Black	9.1
Hispanic	2.0
Asian	1.1
Number of chronic conditions, %	
0	1.3
1	6.1
2	13.1
3	18.9
4	19.1
5	16.9
6	11.7
7	6.7
≥8	5.3
Annual death rate*, % (n)	
2001	15.8 (31,796)
2002	15.2 (25,767)
2003	15.3 (21,990)
2004	15.0 (18,180)
2005	15.3 (15,791)
2006	14.4 (12,594)

Calculated as the number of deaths at year-end/total number of beneficiaries at year-beginning

For a majority of the concordant comorbidities, prevalence decreased across all three age strata, from the youngest to oldest beneficiaries, with no overlap in the corresponding 95% confidence intervals (Fig. 1 and Table 2). For example, prevalence of CKD was 21.8% among the young-old, 21.1% among the middle-old, and 18.4% among the oldest-old. The prevalence of diabetes was 46.2% among the young-old, 38.1% among the middle-old, and 26.9% among the oldest-old. Stroke and AFIB were two concordant conditions that increased rather than decreased in prevalence across all three age strata, from the young-old to the oldest-old.

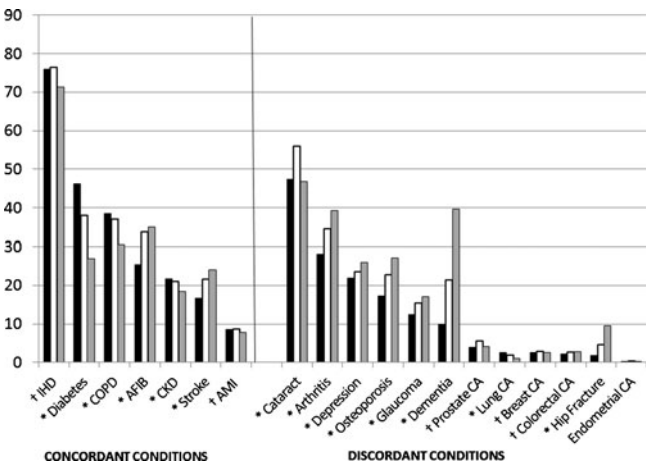

Figure 1. Prevalence of comorbidity by age group, 2001: ■ 66–75 years, □ 76–85 years ▒, 86+ years. *No overlap in 95% confidence intervals (CI) across all three age groups. †No overlap in 95% CI between the youngest (66–75 years) and oldest (86+ years) age group. ‡No overlap in 95% CI between the youngest (66–75 years) and middle (76–85 years) age group.

With the exception of cataracts and cancer, the discordant comorbidities increased in prevalence across all three age strata, from the youngest to oldest beneficiaries, with no overlap in the corresponding confidence intervals. For example, the prevalence of dementia was 9.9% among the young-old, 21.3% among the middle-old, and 39.6% among the oldest-old. The prevalence of hip fracture, while low overall, increased from 1.9%) among the young-old, to 4.6% among the middle-old, and to 9.5% among the oldest-old.

The burden of comorbidity assessed as number of comorbid conditions was higher among those who survived through 2006 than among each of the original three age-stratified subcohorts in 2001 (Fig. 2). In addition, the comorbidity burden significantly increased across the three age strata in both 2001 and 2006. In 2001, the median number of comorbidities was four among each age strata (IQR 2–5 among the young-old; IQR 3–6 among the middle- and oldest-old) (Kruskal-Wallis chi-square= 2,345.34, 2 df, $p < 0.0001$). In 2006, the median number of comorbidities rose to five (IQR 4–7) among the young-old and six (IQR 5–8) among the middle- and oldest-old (Kruskal-Wallis chi-square=1,336.21, 2 df, $p < 0.0001$).

By the end of the study period in 2006, the prevalence of all conditions had increased among those who survived as compared to the prevalence in the original three age-stratified subcohorts (Fig. 3). The pattern of comorbidity prevalence for discordant conditions remained similar in 2006 as compared to 2001 (Fig. 4 and Table 2). For example, while discordant conditions increased the most in prevalence over the study period among the oldest-old compared to the young-old, many of these conditions were already significantly more prevalent among the oldest-old at the start of the study period in 2001. Hip fracture increased by 7.7 percentage points among the oldest-old compared to only 2.2 percentage points among the young-old. Dementia increased in prevalence by 12.8 percentage points among the oldest beneficiaries between 2001 and 2006, compared to only 8.9 percentage points over the same period among the youngest beneficiaries. Because many of the concordant conditions also had the greatest increase in prevalence among the oldest-old, the differences in prevalence across the age strata were narrower in 2006 as compared to 2001. For example, COPD, which was more prevalent among the young-old compared to the oldest-old in 2001, increased in prevalence by 10.5 percentage points among the oldest-old and by 8.5 percentage among the young-old between 2001 and 2006.

DISCUSSION

This study of Medicare beneficiaries age 66 years and older confirms the high overall burden of comorbid disease among older persons with heart failure, which becomes even higher among those who survive with the disease. By examining comorbidity according to different age groups (66–75, 76–85, and 86+), the results demonstrate significant differences in comorbidity prevalence across these age strata. Several concordant comorbidities were more prevalent than discordant comorbidities among younger beneficiaries, while the majority of discordant conditions were more prevalent among the oldest beneficiaries. Over time, comorbidity increased the fastest among the oldest beneficiaries compared to the youngest

Table 2. Prevalence of Comorbidity by Age Group, 2001 and 2006

Concordant condition	2001			2006		
	Prevalence (95% CI)					
	66–75	76–85	86+	66–75	76–85	86+
IHD	75.9 (75.6, 76.3)	76.5 (76.3, 76.8)	71.2 (70.9, 71.6)	86.6 (86.3, 87.0)	87.6 (87.2, 87.9)	84.4 (83.7, 85.0)
Diabetes	46.2 (45.8, 46.6)	38.1 (37.8, 38.4)	26.9 (26.5, 27.2)	56.2 (55.7, 56.7)	47.4 (46.9, 47.9)	36.3 (35.4, 37.1)
COPD	38.5 (38.1, 38.9)	37.0 (36.7, 37.3)	30.6 (30.2, 31.0)	47.0 (46.4, 47.5)	45.3 (44.8, 45.8)	41.1 (40.3, 42.0)
AFIB	25.3 (25.0, 25.7)	33.7 (33.4, 34.1)	35.1 (34.6, 35.5)	36.1 (35.6, 36.6)	44.3 (43.8, 44.8)	43.5 (42.6, 44.4)
CKD	21.8 (21.5, 22.1)	21.1 (20.8, 21.4)	18.4 (18.0, 18.7)	34.6 (34.1, 35.1)	35.7 (35.2, 36.2)	34.0 (33.1, 34.8)
Stroke	16.8 (16.5, 17.1)	21.6 (21.3, 21.9)	24.0 (23.6, 24.3)	26.7 (26.3, 27.2)	32.7 (32.3, 33.1)	34.5 (33.7, 35.6)
AMI	8.6 (8.4, 8.8)	8.6 (8.5, 8.8)	7.8 (7.6, 8.0)	12.2 (11.9, 12.6)	12.5 (12.2, 12.8)	12.3 (11.7, 12.9)
Discordant condition	**Prevalence (95% CI)**					
	66–75	**76–85**	**86+**	**66–75**	**76–85**	**86+**
Cataract	47.3 (46.9, 47.7)	55.9 (55.6, 56.2)	46.8 (46.4, 47.3)	75.4 (75.0, 75.9)	80.1 (79.7, 80.5)	71.3 (70.5, 72.1)
Arthritis	28.1 (27.7, 28.4)	34.6 (34.3, 34.9)	39.2 (38.8, 39.7)	50.8 (50.3, 51.3)	58.2 (57.7, 58.7)	63.2 (62.4, 64.1)
Depression	21.9 (21.6, 22.2)	23.5 (23.2, 23.8)	26.1 (25.7, 26.4)	34.1 (33.6, 34.6)	37.0 (36.5, 37.5)	39.8 (38.9, 40.7)
Osteoporosis	17.3 (17.0, 17.6)	22.8 (22.5, 23.0)	27.2 (26.8, 27.6)	34.9 (34.4, 35.4)	42.9 (42.4, 43.3)	48.4 (47.5, 49.3)
Glaucoma	12.4 (12.1, 12.6)	15.4 (15.2, 15.7)	17.0 (16.7, 17.3)	22.8 (22.4, 23.3)	25.7 (25.3, 26.1)	27.1 (26.3, 27.9)
Dementia	9.89 (9.6, 10.1)	21.3 (21.1, 21.6)	39.6 (39.2, 40.0)	18.8 (18.4, 19.2)	34.0 (33.5, 34.4)	52.4 (51.5, 53.3)
Prostate CA	4.0 (3.8, 4.1)	5.70 (5.5, 5.9)	4.2 (4.0, 4.4)	6.3 (6.1, 6.6)	7.0 (6.7, 7.2)	4.5 (4.1, 4.9)
Lung CA	2.6 (2.5, 2.8)	1.9 (1.8, 2.0)	1.0 (0.9, 1.1)	2.8 (2.6, 2.9)	2.1 (2.0, 2.2)	1.1 (0.9, 1.3)
Breast CA	2.6 (2.4, 2.7)	3.0 (2.9, 3.1)	2.6 (2.5, 2.7)	4.1 (3.9, 4.3)	5.0 (4.8, 5.2)	4.6 (4.2, 4.9)
Colorectal CA	2.1 (2.0, 2.3)	2.7 (2.6, 2.8)	2.7 (2.6, 2.9)	3.4 (3.2, 3.6)	4.2 (4.0, 4.4)	4.3 (4.0,4.7)
Hip fracture	1.9 (1.8, 2.0)	4.6 (4.5, 4.7)	9.5 (9.2, 9.7)	4.2 (3.9, 4.4)	9.2 (9.0, 9.5)	17.2 (16.5, 17.9)
Endometrial CA	0.3 (0.3, 0.4)	0.3 (0.3, 0.4)	0.2 (0.2, 0.3)	0.5 (0.5, 0.6)	0.6 (0.5, 0.7)	0.4 (0.3, 0.5)

beneficiaries, with the greatest prevalence increases in those discordant conditions already more common among the oldest beneficiaries at the start of the study period. These findings support dual hypotheses regarding the relationship between comorbidity and advancing age among older adults with heart failure, namely, that even as the prevalence of comorbidity overall increases over time, the oldest-old continue to be more likely than the young-old to have more discordant conditions and less likely to have concordant comorbidities, particularly those shown to be associated with mortality[6–8,10]. Overall, the rate of accumulation of most discordant conditions (with the exception of cancer) exceeded the rate of accumulation of concordant comorbidities.

Our findings regarding the overall prevalence of comorbidity among older persons with heart failure are consistent with previous studies. The almost 41% of beneficiaries in the current study who had ≥5 comorbid conditions is similar to the 37% in an earlier study of 122,630 Medicare beneficiaries with heart failure with ≥5 comorbid conditions[9]. In contrast, among the general Medicare population, it has been estimated that only 7.6% have ≥3 conditions overall[19]. Our estimates of comorbidity prevalence across age strata are also consistent with existing data; for example, findings from the National Heart Failure Project (NHFP) indicated that diabetes and COPD were more prevalent among adults aged 65–74, while stroke and dementia were more prevalent among adults aged 86 years and over[20]. While the NHFP examined the cross-sectional prevalence of a small set of comorbidities, the current study provides a more comprehensive evaluation of comorbidity by examining the change in prevalence of a broad range of

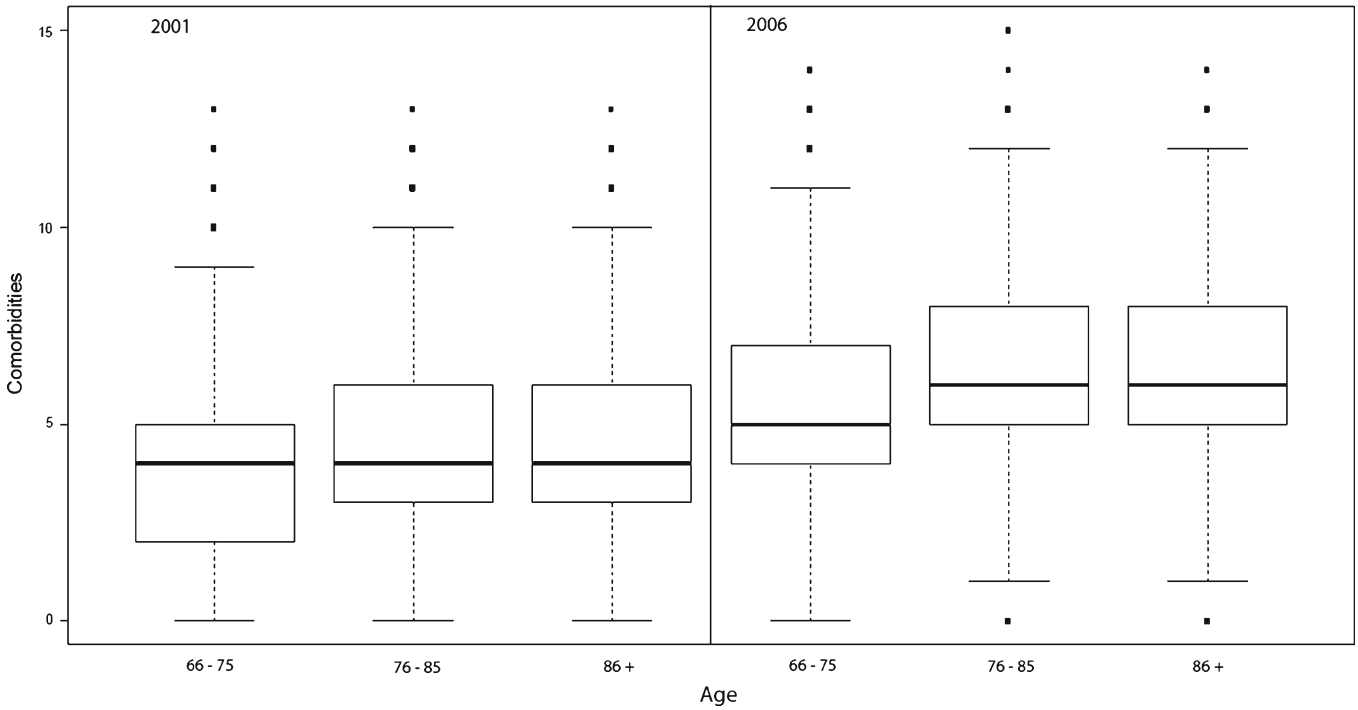

Figure 2. Boxplots of comorbidity burden by age group, 2001 and 2006: ▢ 2001, ■ 2006.

comorbidities over time. The 5-year mortality rate within our study cohort is similar to a previous report examining mortality after initial diagnosis of heart failure as ascertained by chart review[21] and is lower than mortality rates reported among patients recently hospitalized with heart failure[22,23]. However, our findings suggest that heart failure remains a high-risk diagnosis despite the many therapeutic advances aimed at improving survival[24–29].

Our findings highlight some of the challenges to providing optimal care for patients with heart failure. First, the high burden of comorbidity within our study population suggests that the prevailing disease-oriented model of care may not adequately address the health care needs of older adults with heart failure. Clinical guidelines for heart failure focus primarily on interventions directed at the heart failure itself[30,31]. However, the associations between concordant conditions and quality of life outcomes among persons with heart failure[2,3,32–34] suggest that optimizing the health of these patients requires explicit assessment and treatment directed at the comorbid conditions while simultaneously addressing the heart failure.

Second, the finding that the comorbidity profiles of older adults with heart failure shift towards a greater burden of discordant conditions with advancing age suggests that providers will be increasingly challenged to manage a heavy burden of conditions unrelated to heart failure. Successful treatment of co-existing yet unrelated conditions requires considerable time and expertise on the part of the provider and increases the overall complexity of care[17]. The presence of discordant condi-

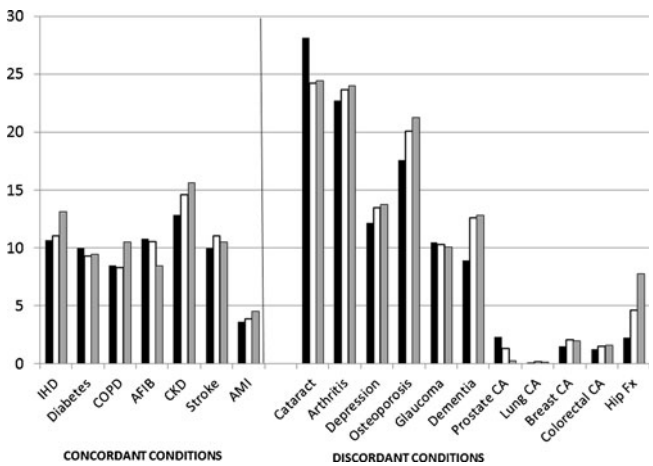

Figure 3. Change in comorbidity prevalence by age group, 2001-2006: ■ 66–75 years, ▢ 76–85 years, ▢ 86+ years. *Change in prevalence reported in absolute numbers.

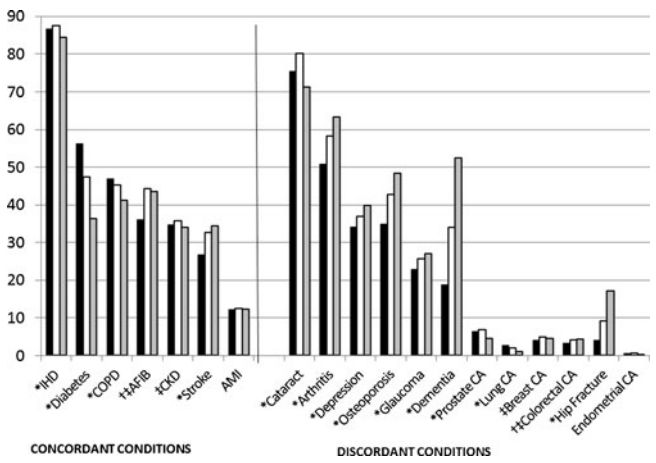

Figure 4. Prevalence of Comorbidity by Age Group, 2006: ■ 66–75 years, ▢ 76–85 years, ▢ 86+ years. *No overlap in 95% confidence intervals (CI) across all three age groups. †No overlap in 95% CI between the youngest (66–75 years) and oldest (86+ years) age group. ‡No overlap in 95% CI between the youngest (66–75 years) and middle (76–85 years) age group.

tions may increase the risk that the patient may receive lower quality care[18,35]. A prior study found that patients with a recent AMI who had discordant comorbid conditions were less likely to receive guideline-recommended post-AMI care than patients with concordant comorbidities[18]. In addition, the application of multiple disease-based guidelines to the individual patient results in complicated and burdensome treatment regimens and is associated with risks of drug-drug and drug-disease interactions[36]. The complexity of managing heart failure in the face of several co-existing conditions calls for a coordinated, comprehensive system of care that can successfully address the multiple and potentially competing needs of patients with heart failure, yet our existing infrastructure remains fragmented and disorganized with poorly defined roles for non-heart failure specialists[37]. A team-based approach to heart failure care led by family physicians and supported by heart failure specialists has been suggested as a possible model for heart failure care[37]; however, to date, the issue of how best to deliver comprehensive care for complex heart failure patients remains unresolved. As the elderly population with heart failure continues to age, it will become of critical importance to determine how best to deliver high quality care by adequately managing both discordant and concordant conditions in a single patient.

Our study has some limitations. We are limited by the use of population-based data to providing associations rather than describing causality between comorbidity and age. The use of administrative data sources for estimating the prevalence of conditions is at risk for underestimating the true burden of disease[38]; however, we believe that our use of the CCW, designed specifically to mitigate the risk of underestimation through the use of evidence-based algorithms to indicate the presence of a disease, facilitated the accurate reporting of disease prevalence. Moreover, a prior study that utilized chart review methods to identify comorbid conditions among older adults with heart failure resulted in similar prevalence estimates[20], providing support for the CCW algorithms as an alternative to more costly and time-consuming methods for identifying comorbidity. Future and ongoing evaluation of the accuracy of CCW-defined conditions will be important in determining the full utility of this data source. We defined conditions as present once the criteria for the algorithm had been met and for all subsequent years that the beneficiary was alive. This raises the possibility that we may have over-reported the prevalence of cataracts within our study sample, since cataracts can be removed and thereby cured. Because we compared the prevalence of 19 different comorbid conditions, it is possible that the significance of our results might be due to chance variation arising from making multiple comparisons. We only have descriptive statistics for characterizing the changes in prevalence over time. We were unable to distinguish between systolic and diastolic heart failure using the CCW data set. As the proportion of diastolic versus systolic heart failure increases with increasing age[39–41], it is possible that comorbidity profiles might also differ according to the type of heart failure. Finally, because we focused on Medicare beneficiaries >65 years of age and excluded beneficiaries enrolled for any period of time in managed care, our findings may not be generalizable to the larger Medicare population.

In conclusion, among older Medicare beneficiaries with heart failure examined according to three age strata, the prevalence of comorbidity differed by age, with a higher overall burden of comorbidity and greater prevalence of discordant comorbid conditions among the oldest-old. The prevalence of comorbidity increased over time across all strata, with discordant comorbidities increasing at the fastest rate among the oldest-old. A model of multimorbidity may be the most appropriate approach to care for the elderly population with heart failure. The increasing prevalence of discordant conditions over time, particularly among those who survive to very old age, highlights the challenge facing providers of effectively treating heart failure while simultaneously managing several co-existing and unrelated conditions.

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