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Sex, quality of care, and outcomes of elderly patients hospitalized with heart failure: Findings from the National Heart Failure Project

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Abstract

Background—Previous studies have demonstrated that women hospitalized for heart failure receive poorer quality of care and have worse outcomes than men. However, these studies were based upon selected patient populations and lacked quality of care measures.

Methods—We used data from the National Heart Failure Project, a national sample of fee-for-service Medicare patients hospitalized with heart failure in the United States in 1998–1999, to evaluate differences in quality of care and patient outcomes between men and women. Multivariable hierarchical logistic regression models and χ^2 analyses were used to examine sex differences in the documentation of left ventricular systolic function (LVSF), prescription of angiotensin-converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs) for patients with left ventricular dysfunction, and mortality within 30 days and 1 year of admission in the study cohort (n = 30 996).

Results—Women had lower overall rates of LVSF assessment than men (64.9% vs 69.5%, $P < .001$). Among patients classified as candidates for ACE inhibitor prescription, women had lower crude rates of ACE inhibitor prescription than men (70.1% vs 74.2%, $P = .015$), but treatment rates were similar when evaluating the prescription of ACE inhibitors or ARBs (78.9% women vs 81.3% men, $P = .11$). Despite lower rates of treatment, women had lower mortality rates than men at 30 days (9.2% vs 11.4%, $P < .001$) and 1 year (36.2% vs 43.0%, $P < .001$) after admission. Results were similar after multivariable adjustment.

Conclusions—There were small sex differences in the quality of care provided to fee-for-service Medicare patients hospitalized with heart failure, although women had higher rates of survival than men up to 1 year after hospitalization.

Women comprise half of all elderly persons with heart failure^{1–3} but may receive poorer quality of care than men with heart failure. Women with heart failure treated in the ambulatory setting are less frequently treated with angiotensin-converting enzyme (ACE) inhibitors,^{4–6} digoxin,⁵ and antiplatelet agents^{6,7} than men. Sex differences in heart failure treatment have also been reported during hospitalization, including lower rates of ACE inhibitor use,^{8,9} combination medical therapy,¹⁰ use of cardiac procedures,^{1,9,11} and poorer performance on other explicit and implicit process-of-care measures,^{12,13} leading to suggestions of gender bias.¹⁰ However, the evidence is not consistent, as other studies of heart failure have reported that women have similar or higher rates of ACE inhibitor prescription,^{14–16} diuretic use,^{5,6,15,16} procedure use,^{9,15} and overall process quality of care as men.¹⁷ Women have also been reported, by some studies, to have better outcomes than men, both after initial diagnosis of heart failure,^{3,18} during hospitalization,¹¹ and after discharge.^{3,7,9,17,19,20–24} Other studies, however, have reported that sex is not an independent risk factor for in hospital mortality¹ or outcomes after discharge^{6,12,15,25,26} and that women may even be at higher risk of mortality than men.²⁷

Discrepant findings concerning the association of patient sex, quality of care, and mortality may reflect the limitations of previous studies. The association of patient sex, quality of care, and mortality has been primarily assessed using data from single centers, specific geographic regions, or selected patient populations^{5,8–18,20,21,25–29} and, thus, may not reflect national patterns of care or outcomes. Prior studies have also commonly utilized administrative data and, thus, been unable to account adequately for clinical characteristics that may confound the association of patient sex, treatment, and outcomes.^{1,3,11,13,19,21,23–25,30}

Accordingly, we sought to examine the association between patient sex and quality of care in an elderly cohort of patients hospitalized with heart failure. Using data from the National Heart Failure (NHF) Project, a systematic national sample of fee-for-service Medicare patients hospitalized for heart failure in 1998–1999 collected as part of Medicare's National Heart Care Project, we sought to determine if women received poorer quality of care than men during hospitalization and had higher rates of mortality.

Methods

National Heart Failure Project

The NHF Project is a Centers for Medicare and Medicaid Services (CMS) initiative to improve the quality of care for fee-for-service Medicare beneficiaries hospitalized with heart failure. Patients hospitalized between March 1998–April 1999 with a principal discharge diagnosis of heart failure (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] codes 402.01, 402.11, 402.91, 404.01, 404.91, or 428)³¹ were identified. The NHF selected admissions of patients with valid social security numbers who were not receiving long-term hemodialysis and did not leave the hospital (transferred out or left against medical advice) during treatment.³² Within each state, 800 records were sampled from all identified admissions that met initial criteria after records were sorted by age, sex, race, and hospital. States with <800 eligible records were sampled in their entirety. Selected records were forwarded to 1 of 2 clinical data abstraction centers and each record was reviewed by trained abstractors for detailed clinical data including medical history, comorbidity, findings at admission, in-hospital course, status at discharge, medication and procedure use, and laboratory and other diagnostic evaluations.

Study cohort

The NHF Project produced an initial sample of 39 477 medical records. Medical records not meeting NHF eligibility criteria (chronic hemodialysis, patient left hospital, did not have a valid social security number, readmissions) during abstraction were excluded (n = 2054),

leaving a cohort of 37 423 patients. We excluded patients <65 years of age (n = 2909) because these Medicare beneficiaries are not representative of the under age 65 population. Patients who arrived by inter-hospital transfer (n = 1046) and those without chart documentation of heart failure on admission (n = 2324) were similarly excluded to ensure examination of a cohort of patients who were admitted to the hospital with heart failure. Patients hospitalized outside of the 50 states and the District of Columbia (n = 627) and those with missing sex (n = 3) were also excluded. In total, 6427 patients met ≥ 1 of the above criteria; the remaining 30 996 patients comprised the study cohort.

Additional data sources

Data from the NHF Project was linked with the American Medical Association Physician Masterfile³³ using the unique physician identification number corresponding to the attending physician for each hospitalization in the NHF dataset. Physician characteristics of interest included board certification and self-reported specialty. Hospital characteristics, including bed size, geographic location (rural location, US Census region), level of cardiac care facilities, ownership, and teaching status were obtained by linking the NHF to the 1998 American Hospital Association Annual Survey of Hospitals database.³⁴ Patient mortality was determined using the Medicare Enrollment Database.³⁵

Quality of care and mortality

Centers for Medicare and Medicaid Services' evaluation of patients' treatment focused principally on prescription of ACE inhibitors and the documentation of left ventricular systolic function (LVSF), both recognized measures of heart failure quality of care.³⁶ Documentation of LVSF was defined as a medical record notation of prior LVSF evaluation with a reported LVSF, in-hospital assessment of LVSF, or a notation of a planned post-discharge LVSF assessment among patients who survived to discharge. We assessed the prescription of ACE inhibitors at discharge among patients with left ventricular systolic dysfunction (defined as either a qualitative assessment of moderate or severe left ventricular systolic dysfunction or a quantitative left ventricular ejection fraction <0.40) who had no treatment-specific contraindications. Because some physicians may have prescribed angiotensin receptor blockers (ARBs) instead of ACE inhibitors (a substitution not supported by current ACC/AHA clinical practice guidelines),³⁷ we also examined the use of ACE inhibitors or ARBs among patients with left ventricular dysfunction and no treatment specific contraindications to ACE inhibitors. Quality of care indicators are described in greater detail in Table I. Patient mortality was assessed at 30 days and 1 year after admission.

Statistical analysis

We compared differences between women and men in patients' medical history, comorbidities, admission characteristics, attending physician and treating hospital characteristics, and eligibility for each of the quality indicators using χ^2 and Wilcoxon rank-sum tests.

Unadjusted differences in prescription of ACE inhibitors, LVSF documentation, 30-day, and 1-year mortality between men and women were assessed using χ^2 tests. Multivariable analyses were performed to determine if sex differences in quality of care or outcomes were independent of other factors. Because of the hierarchical nature of the NHF cohort (patients clustered within physicians, physicians clustered within hospitals, hospital clustered within states), mixed-effects multilevel modeling was conducted. Multilevel logistic regression models adjusted for patient characteristics utilized in a previous study³⁸ including age, race, left ventricular systolic function (ejection fraction <40%, ejection fraction $\geq$ 40%, ejection fraction unknown), medical history (coronary artery disease, chronic obstructive pulmonary disease, dementia, nursing home admission), disease severity (as measured by a modified version of the Medicare Mortality Prediction System score,³⁹ including age, cancer, mobility, prior congestive heart

failure, mean arterial pressure, heart rate, serum urea nitrogen, white blood cell count, and the Acute Physiology and Chronic Health Evaluation [APACHE] II score), and admission characteristics (heart rate, sodium, serum creatinine). Analyses also adjusted for attending physician specialty and board certification, and hospital characteristics including number of beds, rural location, ownership, teaching status, and level of cardiac care facilities. The model intercept and patient sex were initially entered as random coefficients in all analyses; all other variables were modeled as fixed effects. Dummy variables were used to denote patients with missing physician or hospital characteristic information. Odds ratios were converted to estimated risk ratios.⁴⁰ Mortality analyses were repeated stratifying by history of coronary disease, age, hypertension, and renal disease to assess the robustness of sex differences in patient outcomes.

All analyses used probability weights, based on each state's inverse sampling fraction, to ensure statistical analyses accounted for the NHF's sampling design. Statistical analyses were conducted using Stata 7.0 (Stata Corporation, College Station, Texas) and MLwiN (Institute of Education, London, United Kingdom). Analysis of the National Heart Failure Project database was approved by the Yale University School of Medicine Human Investigation Committee.

Results

Women were older and a smaller proportion had a history of coronary disease, chronic obstructive pulmonary disease, or prior use of coronary revascularization compared with men. A greater proportion of women had preserved left ventricular function, but women had higher rates of other comorbid conditions than men, including hypertension, and functional limitations (incontinence, admission from nursing home). Fewer women were treated by a cardiologist than men; there were no other notable sex differences in patients' characteristics (Table II).

Overall, 95% of patients were classified as eligible for assessment of LVSF and 17% were classified as candidates for ACE inhibitor prescription. Although women and men were equally eligible for the documentation of LVSF, women were less likely to be classified as candidates for the prescription of ACE inhibitors (Table III).

Women had lower crude rates of LVSF documentation than men (64.9% vs 69.5%, $P < .001$). Among patients classified as candidates for ACE inhibitor use, women were less likely to be prescribed ACE inhibitors (70.1% vs 74.2% men, $P = .015$), but had comparable rates of ACE inhibitors or ARB prescription as men (78.9% vs 81.3% men, $P = .11$) (Table III).

Women remained slightly less likely to have LVSF documented (RR 0.93, 95% CI 0.91–0.95) than men after multivariable adjustment. Among patients classified as candidates for ACE inhibitor prescription, women continued to be less likely to be prescribed ACE inhibitors than men (RR 0.88, 95% CI 0.84–0.92) after multivariable adjustment, but had a comparable likelihood of being prescribed an ACE inhibitor or ARB (RR 0.97, 95% CI 0.94–1.01).

Women had lower mortality rates than men at 30 days (9.2% vs 11.4%, $P < .001$) and 1 year (36.2% vs 43.0%, $P < .001$) after admission. Sex differences in 30-day and 1-year mortality rates were similar when patients were stratified by history of coronary disease, hypertension, renal disease, and age (Table IV). Mortality risks remained lower in women than men at 30 days (RR 0.75, 95% CI 0.70–0.82) and 1 year (RR 0.85, 95% CI 0.82–0.88) after admission.

Discussion

Our evaluation of a national cohort of fee-for-service Medicare beneficiaries hospitalized for heart failure identified small absolute differences in quality of care. The shortfall in quality of

care from optimal levels for both women and men was much larger than the difference between the sexes. Moreover, despite the small sex differences in quality of care, women had lower rates of mortality than men up to 1 year after hospitalization. These findings persisted after multivariable adjustment, confirming that, among fee-for-service Medicare beneficiaries, women have better outcomes than men after hospitalization for heart failure.

The observed differences in quality of care for women hospitalized with heart failure are small, but nonetheless troubling. Although the absolute sex differences in treatment rates were modest, they may conceivably result in the under-treatment of a substantial group of women given the nearly 1 million patients hospitalized for heart failure in the United States each year.⁴¹ It is unclear what factors may account for these differences given that a wide range of clinical factors were included in multivariable analysis. Women generally had a higher prevalence of comorbid illness than men, which may have influenced physicians' willingness to provide treatment in a manner not accounted for in our multivariable models. For instance, the higher rates of ARB prescription in lieu of ACE inhibitors among women may be appropriate as women are more likely to report side effects on ACE inhibitor therapy than men.⁴² Elderly women have fewer economic resources than men, raising the possibility that sex differences in treatment may reflect, in part, the influence of socioeconomic factors.⁴³ We were unable to assess patient preferences and, thus, cannot discount sex differences in patients' preferences for treatment as a possible explanation. Alternatively, the well-documented sex differences in treatment for other cardiac conditions,⁴⁴ suggest that sex may also independently influence treatment for patients hospitalized with heart failure. However, the notable sex differences in baseline characteristics and the modest size of the treatment difference between men and women raises the likelihood that sex differences in care may be attributable to unmeasured residual confounding.

Despite the small differences in treatment, women had lower rates of mortality than men up to 1 year after hospitalization. This finding is consistent with literature documenting higher rates of survival in women than men with heart failure.^{11,18,19,29} Although lower rates of ischemic disease are believed to account for the survival advantage in women, this difference persisted after accounting for heart failure etiology and was consistent across different clinical strata. Women had higher survival rates after accounting for sex differences in left ventricular systolic function, indicating differences in outcomes were not due to a higher prevalence of preserved systolic function in women. The lower rates of mortality in women likely do not reflect selection via a survivor effect given that markedly fewer women die before the age of 65 years compared with men. Sex differences in mortality may reflect sex differences in myocardial adaptation to pressure overload,⁴⁵ lower rates of aging-related cardiac myocyte cell loss and reactive hypertrophy,⁴⁶ or some other as-yet-unidentified sex-associated physiological process.^{7,22}

The National Heart Failure Project provides a nationally representative, community-based, contemporary evaluation of in-hospital treatment provided to elderly patients hospitalized with heart failure. However, our study has certain limitations that merit consideration. First, because our sample included fee-for-service Medicare patients ≥ 65 years of age who were hospitalized with heart failure, these findings may not be applicable to patients < 65 years of age or patients enrolled in Medicare managed care plans. However, $> 80\%$ of patients with heart failure in the United States are > 65 years of age, suggesting this exclusion results in only a minimal loss in generalizability.⁴¹ Second, we restricted our evaluation to patients hospitalized for heart failure and, thus, our findings may not apply to patients in the ambulatory setting. However, acute exacerbations of heart failure requiring hospitalization are common, particularly among elderly patients.²¹ In addition, a hospitalization provides a well-defined episode of care that is well-suited to studies of sex differences in quality of care by reducing concerns of differential access to care. More importantly, clinical guidelines concerning the management of patients

hospitalized with heart failure allow for the development of rigorous, transparent measures of quality that may be used to assess care during hospitalization, rather than resource-oriented measures such as costs of procedure use. However, it is conceivable that sex may have influenced treatment in a manner not captured in our quality of care measures. Finally, our assessment of patient outcomes was restricted to mortality and, thus, we cannot assess sex differences in other important endpoints, including morbidity and health status.

Conclusion

Our evaluation of a large, nationally representative, community-based cohort of elderly fee-for-service Medicare beneficiaries hospitalized with heart failure identified modest differences between the quality of care provided to men and women. Although it is unclear whether these differences reflect independent associations with sex or are attributable to other sex-associated factors, there is sufficient evidence supporting these processes of care to increase their use in all eligible patients hospitalized with heart failure. Additional efforts are needed to improve the quality of care and survival among elderly patients with heart failure.

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Table I

Quality indicator eligibility criteria

Prescription of ACE inhibitors *

Eligibility

- Patient alive at time of discharge
- Evidence of left ventricular systolic dysfunction during hospitalization (LVEF <40%)
- No moderate or severe aortic or bilateral renal artery stenoses
- No physician documentation of any reason for withholding ACE inhibitor therapy
- Patient not enrolled in ACE inhibitor or other clinical trials
- Serum creatinine <3.0 mg/dL
- Systolic blood pressure 70 mm Hg or higher throughout hospitalization
- Serum potassium <7.0 mg/dL

Quality of care measure

- ACE inhibitor prescribed on discharge

Current LVSF measurement

Eligibility

- Patient alive at time of discharge

Quality of care measure

- LVSF assessed prior to hospitalization and noted in medical record
- Patient received LVSF assessment during hospitalization
- Patient scheduled to receive LVSF evaluation after discharge

*

Same criteria used to evaluate prescription of ACE inhibitors or ARBs.

Table II

Patient, hospital, and physician characteristics

Characteristics	Overall	Men	Women	P
Percent of patients	100	40.3	59.7	-
Mean age, years	79.5	78.0	80.5	<.001
Patient race				.001
White	85.2	86.7	84.1	
Black	11.2	10.0	12.0	
Other/unknown	3.6	3.3	3.8	
Admission characteristics				
Mean systolic blood pressure, mm Hg	146.5	141.4	149.9	<.001
Mean diastolic blood pressure, mm Hg	78.2	77.8	78.5	.021
Mean heart rate, beats/min	90.9	89.4	92.0	<.001
Peripheral edema	71.2	73.2	71.1	.003
Cardiac arrest	1.8	2.4	1.4	<.001
Medical history				
Prior congestive heart failure	72.4	72.8	72.2	.34
Left ventricular ejection fraction				<.001
≥40%	32.6	26.4	36.8	
< 40%	30.3	39.2	24.2	
Unknown	37.1	34.4	39.0	
Prior myocardial infarction	28.7	34.4	24.9	<.001
Prior coronary disease	57.2	65.8	51.5	<.001
Angina	17.8	17.0	18.4	.012
Hypertension	62.2	57.0	65.8	<.001
Diabetes	39.0	40.0	38.3	.025
Prior coronary bypass graft surgery	22.1	32.4	15.2	<.001
Prior angioplasty	8.5	10.4	7.3	<.001
Prior cerebrovascular disease	18.2	18.8	17.8	.10
Chronic obstructive pulmonary disease	33.4	37.2	30.8	<.001
Dementia/Alzheimer's disease	9.7	7.9	11.0	<.001
Mobility				<.001
Independent self-ambulation	32.4	38.0	28.5	
Dependent	39.6	33.3	43.9	
Unknown	28.0	28.6	27.6	
Urinary continence				<.001
Continent	54.2	58.6	51.2	
Incontinent	14.9	11.9	17.0	
Unknown	30.9	28.5	31.8	
Admission source				<.001
Home	69.0	71.8	67.0	
Skilled nursing or other facility	11.2	7.4	13.7	
Outpatient setting	15.0	16.5	14.0	
Other	4.8	4.3	5.2	
Admission laboratory findings				
Mean sodium	138.6	138.8	138.5	.003
Mean serum creatinine	1.4	1.6	1.3	<.001
Hospital Characteristics				
Hospital data available	96.4	96.7	96.1	.07
Ownership				.28
Public	13.0	12.9	13.0	
Not-for-profit	71.3	71.7	71.1	
For-profit	12.1	12.1	12.1	
Teaching status				.08
Council of Teaching Hospitals member	12.3	12.9	11.9	
Residency-affiliated	20.8	21.0	20.6	
Non-teaching	63.3	62.8	63.6	
Mean number of beds	296	299	293	.14
Located in an urban area	72.8	73.9	72.1	.016
Cardiac care facilities				.024
Cardiac surgery suite	34.8	35.9	34.0	
Cardiac catheterization lab	20.2	20.2	20.2	
No invasive facilities	41.4	40.6	42.0	
Census region				.027
Northeast	20.9	21.0	20.8	
Midwest	26.4	26.5	26.3	
South	39.2	38.5	39.6	
West	10.0	10.7	9.5	
Physician characteristics				
Physician data available	88.1	88.3	88.0	.49
Female	7.6	6.4	8.4	<.001
Race				.71
White	45.7	45.6	45.8	
Black	1.5	1.4	1.6	
Other	14.3	14.4	14.2	

Characteristics	Overall	Men	Women	<i>P</i>
Unknown/missing	38.6	38.6	38.5	<.001
Physician specialty				
Cardiologist	21.7	25.3	19.2	
Internist	42.3	40.3	43.6	
Family practice	20.7	19.4	21.6	
Other	15.3	15.0	15.6	<.001
Board certification	68.3	70.1	67.1	
Foreign medical graduate	25.5	25.4	25.5	
Mean years in practice	21.2	21.3	21.1	.21

Table III

Eligibility and treatment by quality indicators

	Overall	Men	Women	P
Patients classified as ideal candidates*				
Prescribed ACE inhibitors	16.7	20.9	13.8	<.001
Documentation of left ventricular systolic function	94.8	94.4	95.1	.06
Treatment among ideal candidates				
Prescribed ACE inhibitors	72.2	74.2	70.1	.015
Prescribed ACE inhibitors or ARBs	80.1	81.3	78.9	.11
Documentation of left ventricular systolic function	66.7	69.5	64.9	<.001

* Same cohort for the evaluation of the prescription of ACE inhibitors or ARBs.

Table IV

Patient sex and crude mortality rates, overall and by selected characteristics

	30-Day mortality				1-Year mortality					
	Overall	Men	Women	P	Interaction P	Overall	Men	Women	P	Interaction P
Overall	10.1	11.4	9.2	<.001	-	38.9	43.0	36.2	<.001	-
Subgroups										
Age					.61					.58
65–75 years	6.9	8.3	5.6	<.001		30.6	34.5	26.9	<.001	
75–84 years	9.5	11.1	8.3	<.001		37.9	43.7	33.7	<.001	
≥85 years	14.4	17.6	13.0	<.001		49.2	56.1	46.4	<.001	
Hypertension					.14					.061
No	12.2	13.1	11.5	.045		43.4	47.6	39.9	<.001	
Yes	8.8	10.2	8.0	<.001		36.2	39.5	34.3	<.001	
History of coronary disease					.39					.62
No	10.1	11.9	9.2	<.001		37.4	42.0	35.2	<.001	
Yes	10.1	11.2	9.2	.002		40.1	43.5	37.1	<.001	
Serum creatinine					.64					.44
<1.5	7.8	8.5	7.5	.062		33.1	35.7	31.8	<.001	
>1.5	15.2	15.8	14.5	.20		52.0	53.6	50.2	.017	