Sex Differences in Cardiac Catheterization after Acute Myocardial Infarction: The Role of Procedure Appropriateness

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Background: **Many studies have found that women are less likely than men to have cardiac catheterization after an acute myocardial infarction; however, it is unknown whether sex differences reflect inappropriate treatment.**

Objective: **To ascertain whether cardiac catheterization use after acute myocardial infarction in men and women varied by sex and the appropriateness of the procedure, as determined by clinical guidelines.**

Design: **Retrospective analysis of chart-abstracted data.**

Setting: **U.S. acute-care hospitals.**

Patients: **143 444 Medicare patients who were hospitalized for acute myocardial infarction between 1994 and 1996.**

Measurements: **Cardiac catheterization use within 60 days of hospitalization for acute myocardial infarction.**

Results: **Women had lower crude rates of cardiac catheterization than men (35.7% for women vs. 46.5% for men [$P < 0.001$]; difference, 10.8 percentage points). Multivariable adjustment for demographic, clinical, and hospital characteristics reduced most of the sex differences in procedure use (risk-standardized rates, 40.3% for women vs. 41.9% for men [$P < 0.001$]; difference, 1.6 percentage points). Sex differences in cardiac catheterization use varied by the appropriateness of the procedure. Risk-standardized rates of cardiac catheterization were similar for men and women with strong indications for the procedure (44.1% for women vs. 44.6% for men [$P > 0.2$]; difference, 0.5 percentage point). Rates of cardiac catheterization use among patients with weak indications did not significantly differ between men and women (16.5% for women vs. 18.0% for men [$P = 0.096$]; difference, 1.5 percentage points). Sex differences in cardiac catheterization use were largest for patients with equivocal indications (39.4% for women vs. 42.5% for men [$P < 0.001$]; difference, 3.1 percentage points).**

Conclusions: **Among elderly persons, women have lower rates of cardiac catheterization use after an acute myocardial infarction than men. However, this difference was attenuated after multivariable adjustment, and it occurred primarily in patients with equivocal indications. We found no sex variations in procedure use among patients who had strong indications for cardiac catheterization.**

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Data on sex variations in use of cardiac catheterization after an acute myocardial infarction are mixed, with some studies reporting that the procedure is used less often in women (1–13) and others finding no sex differences in use of the procedure (9, 14–19). Despite these conflicting findings, some observers have suggested that sex variations in cardiac care are evidence of sexual discrimination by physicians (20, 21) and reflect a pervasive gender bias in the health care system (22). Although studies of cardiac catheterization use have examined the effect of clinical (1–6, 8, 10, 12, 13, 23), hospital (5, 8, 13), and payer characteristics on sex differences in cardiac procedure use (1–5, 8, 10, 13), few have investigated the contribution of procedure appropriateness to sex differences in procedure use. Without considering the appropriateness of cardiac catheterization for an individual patient, it is unclear whether sex variations in cardiac catheterization use reflect proper clinical practice based on a difference of need, undertreatment of women, overtreatment of men, or a combination of factors. The few studies that have examined sex differences in cardiac catheterization use after adjusting for appropriateness of the procedure have included small numbers of patients from single centers or other selected populations and have reported conflicting results (18, 24–26). Thus, the extent to which sex differences in cardiac catheterization use after an acute myocardial infarction may be attributed to sex differences in appropriateness of the procedure is unknown.

We evaluated data from the Cooperative Cardiovascular Project (CCP), a set of medical record data abstracted for Medicare beneficiaries hospitalized with acute myocardial infarction between 1994 and 1996, to determine whether patient appropriateness for cardiac catheterization explained sex differences in procedure use. Specifically, we sought to evaluate whether sex differences in cardiac catheterization use were seen in patients with strong indications, equivocal indications, or weak indications for the procedure.

METHODS

CCP and the Study Cohort

The CCP has been described in greater detail elsewhere (27). Briefly, Medicare patients hospitalized with a primary discharge diagnosis of acute myocardial infarction (International Classification of Diseases, 9th Revision, clinical modification [ICD-9-CM], code 410.X, with the exception of readmissions code 410.X2) (28) were sampled, by state, for an 8-month period between January 1994 and February 1996. Among the 234 769 hospitalizations abstracted, we excluded patients who were younger than 65 years of age ($n = 17\,593$), were not hospitalized with a chart-confirmed myocardial infarction ($n = 31\,186$), or had transferred into the index hospital ($n = 42\,278$). Pa-

Context

Women have cardiac catheterization after an acute myocardial infarction less often than men; however, the reason—gender bias or clinical factors—is unknown.

Contribution

This large retrospective study of elderly Medicare patients compared numbers of indicated (guideline-recommended) and actual catheterizations performed within 60 days of acute myocardial infarction for women and men. Overall, women less often had cardiac catheterization than men but rates of the procedure did not differ between women and men with clear-cut guideline indications for catheterization.

Implications

Differences in catheterization use after acute myocardial infarction usually reflect appropriate clinical decisions rather than gender bias.

–The Editors

tients were sorted by admission date, and readmissions during the study period were excluded ($n = 23\,773$). We also excluded patients for whom American Hospital Association ($n = 2363$), 1990 U.S. Census ($n = 6322$), or Medicare Part A ($n = 34\,187$) data were not available. Finally, we excluded 1765 patients hospitalized outside of the United States, 61 patients whose race or ethnicity were unknown, and 308 patients whose mortality status was unknown at follow-up. A total of 91 325 patients met one or more of these criteria; the remaining 143 444 patients constitute the study cohort.

Appropriateness of Cardiac Catheterization

Indications for having cardiac catheterization were evaluated after the acute phase of infarction (>12 hours after symptoms onset). Using the 1996 American College of Cardiology/American Heart Association (ACC/AHA) guidelines (29) and appropriateness criteria previously reported by Guadagnoli and colleagues (30), we classified patients into three groups (**Table 1**). The strong indication group consisted of patients in whom cardiac catheterization was generally recognized as "beneficial, useful, and effective" (ACC/AHA class I) (29). The equivocal group included patients in whom data on the effectiveness of the procedure were unclear (ACC/AHA class IIa [evidence may favor cardiac catheterization]; ACC/AHA class IIb [evidence may not favor cardiac catheterization]) or patients with uncomplicated myocardial infarctions (neither ACC/AHA class I, class II, nor class III). The weak indication group included patients who had conditions for which cardiac catheterization was considered unlikely to be effective (ACC/AHA class III). For patients who met more than one classification criterion (for example, a patient who had angina for more than 24 hours after admission and concomitant hepatic failure), classifications were prioritized by using the following order: weak indications (class III), strong indications (class I), equivocal indications (class IIa and class IIb); this was done to maximize specificity among patients classified as having a strong indication.

Cardiac Catheterization Use

The principal outcome was the use of nonacute cardiac catheterization within 60 days of hospital admission, as determined by evaluating the hospital medical record and Medicare Part A billing records for ICD-9-CM procedure codes associated with cardiac catheterization (37.22, 37.33, 88.53–88.57). We did not include cardiac catheterizations conducted within the first 12 hours of hospitalization because these were associated with the use of primary percutaneous transluminal coronary angioplasty.

Statistical Analysis

We compared men and women for differences in medical history, clinical presentation, comorbid conditions, physician, and hospital characteristics using chi-square and *t*-test analyses. We also compared men and women by the appropriateness criteria and the ACC/AHA cardiac catheterization classes used to create the appropriateness groupings.

We compared the crude rates of cardiac catheterization use for men and women in the full study cohort and when stratified by procedure appropriateness (strong, equivocal, or weak). Logistic regression models were used to derive predicted and risk-standardized rates of cardiac catheterization for men and women, adjusting for differences in sociodemographic characteristics, medical history and clinical presentation, physician characteristics, and hospital data associated with cardiac catheterization use in previous analyses (31, 32). Patient sociodemographic characteristics included race and residential ZIP code measures of median household income; distribution of occupations; and percentage of population with a high school education or higher, as reported in the 1990 U.S. Census (33). We based medical history measures on clinical experience and

Table 1. **Cardiac Catheterization Appropriateness Criteria***

Strong indications (based on ACC/AHA class I)
Angina >24 hours after admission
Ischemia observed on an exercise stress test
Reinfarction during hospitalization
Hypotension during hospitalization
Shock on admission or during hospitalization
Equivocal indications (based on ACC/AHA class IIa and class IIb)
Left ventricular ejection fraction < 0.40
Previous bypass surgery or angioplasty
Congestive heart failure or pulmonary edema on admission or during hospitalization
Non–Q-wave myocardial infarction
Weak indications (based on ACC/AHA class III)
Hepatic failure
Metastatic cancer
Terminal illness (life expectancy < 6 months)
Flexion withdrawal, decorticate, decerebate, or no motor response to cues

* Derived from ACC/AHA guidelines (29) and Guadagnoli (30). ACC/AHA = American College of Cardiology/American Heart Association.

previously identified predictors of procedure use. These measures included age, left ventricular ejection fraction, a previous myocardial infarction, congestive heart failure, smoking status, hypertension, diabetes, cerebrovascular disease, peripheral vascular disease, dementia, functional status, and immune system status (compromised or not compromised). We also accounted for the following characteristics ascertained at admission: systolic blood pressure, heart rate, Killip class, infarct location, renal dysfunction, Q-wave infarction, ST-segment elevation, microalbuminuria, anemia, and provision of immediate reperfusion therapy (thrombolytic agents or primary percutaneous transluminal coronary angioplasty within 12 hours of admission).

Physician characteristics included age, sex, and specialty, as reported in the American Medical Association Masterfile (34). Hospital data were obtained from the 1994 American Hospital Association Survey of Hospitals (35) and included level of cardiac care facilities (none, catheterization laboratory, or coronary bypass surgery suite), ownership (public, not-for-profit, or for-profit), teaching status, number of patients with myocardial infarction who were treated, rural location (location outside of a Metropolitan Statistical Area), and U.S. Census division. To retain all variables in multivariable modeling, dummy variables were used to denote patients with missing data for left ventricular ejection fraction ($n = 52\,347$), microalbuminuria ($n = 37\,683$), weight ($n = 12\,056$), functional status ($n = 3325$), anemia ($n = 3232$), systolic blood pressure ($n = 748$), and physician characteristics ($n = 13\,177$).

Risk-standardized rates of cardiac catheterization for men and women were compared in both the overall cohort and within procedure appropriateness groups. The interaction between sex and cardiac catheterization appropriateness was confirmed by the incorporation of terms representing an interaction between patient sex and cardiac catheterization appropriateness and the use of a likelihood ratio test comparing the multivariable logistic regression model incorporating patient sex and cardiac catheterization appropriateness terms with a model that did not include these terms. To adjust for sex-associated differences in patient refusal, we repeated our analyses and evaluated the composite end point of cardiac catheterization within 60 days of hospitalization or refusal of cardiac catheterization during hospitalization. We conducted secondary analyses by further stratifying patients with equivocal indications into those who met class IIa criteria, those who met class IIb criteria, and those who did not meet class I, class II, or class III criteria. Results were adjusted for clustering of patients by hospital by using Huber–White robust estimates of standard error (36). Statistical analyses were conducted by using SAS software, version 6.12 (SAS Institute, Inc., Cary, North Carolina) and Stata software, version 6.0 (Stata Corp., College Station, Texas); data analysis was conducted under the auspices of Qualidigm (Middletown, Connecticut), the Connecticut Peer Review Organization.

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RESULTS

Patients were predominantly white, the mean age was 77 years, and 51% of the patients were men. Compared with men, women were older and were more likely to be black and to have hypertension, diabetes, congestive heart failure, dementia, and limited functional status. However, women were less likely to have had a previous myocardial infarction or to have undergone previous cardiac procedures. Women were also more likely to have been admitted from a nursing home, more likely to have been treated at a smaller-volume hospital, and less likely to have been treated by a cardiologist or board-certified physician (**Table 2**).

Of the 143 444 patients in the study cohort, 66 691 (46.5%) had strong indications for cardiac catheterization, 67 953 (47.4%) had equivocal indications for cardiac catheterization, and 8800 (6.1%) had weak indications for cardiac catheterization. Among patients with equivocal indications, 40 693 (28.4%) met class IIa criteria; 10 868 (7.6%) met class IIb criteria; and 16 392 (11.4%) did not meet class I, class II, or class III criteria. Women were more likely than men to have strong indications for cardiac catheterization (48.4% for women vs. 44.6% for men), were less likely to have equivocal indications (45.8% for women vs. 48.9% for men), and were similar to men in the proportion of patients classified as having weak indications (5.8% for women vs. 6.5% for men) ($P = 0.001$).

Women had lower overall crude rates of cardiac catheterization than men (35.7% [CI, 35.3% to 36.0%] vs. 46.5% [CI, 46.2% to 46.9%]) ($P < 0.001$). Sex differences in crude rates of cardiac catheterization were largest among patients with equivocal indications for cardiac catheterization (34.2% in women [CI, 33.7% to 34.7%] vs. 47.5% in men [CI, 47.0% to 48.0%]) ($P = 0.001$) (**Table 3**). Among patients who had cardiac catheterization, 50.1% had strong indications, 47.4% had equivocal indications, and 2.6% had weak indications. Men who had cardiac catheterization were more likely than women to have equivocal indications for cardiac catheterization (49.9% for men vs. 44.0% for women) and less likely to have strong indications (47.3% for men vs. 53.8% for women) ($P = 0.001$).

Multivariable adjustment reduced the sex difference in cardiac catheterization use; overall risk-standardized rates of cardiac catheterization were slightly lower among women than men (40.3% in women [CI, 40.0% to 40.8%] vs. 41.9% in men [CI, 41.6% to 42.4%]) ($P < 0.001$). Sex differences in cardiac catheterization use varied

Table 2. **Patient Characteristics***

Variable	All Patients (n = 143 444)	Men (n = 72 975)	Women (n = 70 469)	P Value
Race: white/black/other, *n*	90.6/6.2/3.1	91.5/5.1/3.4	89.7/7.4/2.9	0.001
Mean age ±SD, *y*	76.5 ± 7.4	75.2 ± 6.9	78.0 ± 7.6	<0.001
Mean annual household income ±SD, *U.S. $*	30 523 ± 11 508	30 884 ± 11 686	30 192 ± 11 311	<0.001
Clinical presentation, %				
Killip class: I/II/III/IV	50/12/35/2	54/12/32/2	47/2/38/2	0.001
LVEF: unknown/<0.20/0.20–0.39/0.40–0.54/≥0.55	36/2/19/30/12	36/2/20/30/12	37/1/17/31/13	0.001
Anterior infarction	46.7	45.4	48.1	0.001
Q-wave infarction	59.7	60.2	59.2	0.001
ST–segment elevation infarction	29.2	29.6	28.8	0.001
Medical history, %				
Hypertension	61.7	55.7	67.8	0.001
Diabetes mellitus	30.6	28.2	33.2	0.001
Previous myocardial infarction	29.2	32.9	25.4	0.001
Congestive heart failure	21.5	18.4	24.8	0.001
Current smoker	14.7	16.0	13.3	0.001
Cerebrovascular disease	14.0	13.6	14.4	0.001
Peripheral vascular disease	10.7	11.6	9.8	0.001
Previous coronary artery bypass graft surgery	12.4	16.6	8.0	0.001
Previous percutaneous transluminal coronary angioplasty	6.4	7.6	5.2	0.001
Comorbid conditions, %				
Dementia	6.1	4.8	7.5	0.001
Anemia	7.1	6.3	7.9	0.001
Liver disease	0.4	0.4	0.3	0.002
Chronic obstructive pulmonary disease	20.4	22.6	18.1	0.001
Mobility: independent/assisted/unable/unknown	78/16/3/3	84/12/2/2	73/20/4/3	0.001
Urinary incontinence or anuria	7.4	5.4	9.4	0.001
Nursing facility admission	6.8	4.0	9.7	0.001
Do-not-resuscitate order before admission	9.4	6.7	12.3	0.001
Mean APACHE II score ± SD	9.8 ± 4.8	9.7 ± 4.8	9.8 ± 4.8	<0.001
Physician characteristics, %				
Race: white/black/other/unknown	54.0/1.0/12.3/32.6	53.8/1.1/12.5/32.7	54.2/0.9/12.2/32.6	0.001
Male	93.6	94.7	92.4	0.001
Board-certified	81.4	82.4	80.3	0.001
Specialty				0.001
Cardiology	30.8	33.7	27.9	
Medicine subspecialty	11.2	10.5	11.8	
Internal medicine	25.4	24.2	26.7	
Family practice	15.4	14.3	16.5	
Other	17.2	17.3	17.1	
Hospital characteristics				
Level of cardiac care facilities, %				0.001
No invasive facilities	37.8	36.9	38.7	
Catheterization available	25.7	25.3	26.2	
Coronary artery bypass graft surgery available	36.5	37.8	35.1	
Ownership: public/not-for-profit/for-profit, %	12.4/77.0/10.5	12.4/77.0/10.6	12.4/77.1/10.5	>0.2
Teaching status, %				0.024
Nonteaching hospital	66.8	66.8	66.8	
Residency or fellowship program affiliated	21.7	21.9	21.5	
Council of Teaching Hospitals hospital	11.4	11.2	11.6	
Mean acute myocardial infarction volume ± SD, *n*	171 ± 145	174 ± 148	168 ± 143	<0.001
Rural location, %	21.4	21.3	21.5	>0.2
Geographic location, %				0.001
Northeast	25.2	24.2	26.3	
South	37.1	37.2	37.0	
Midwest	21.9	21.6	22.2	
West	15.8	17.0	14.5	

*APACHE = Acute Physiology and Chronic Health Evaluation; LVEF = left ventricular ejection fraction.

on the basis of patient appropriateness for cardiac catheterization ($P < 0.001$ for the interaction between patient sex and cardiac catheterization appropriateness) (**Table 3**). Men and women with strong indications had identical risk-standardized rates of cardiac catheterization use (44.1% in women [CI, 43.2 to 44.9] vs. 44.6% in men [CI, 44.0 to 45.3]) ($P > 0.2$). Similarly, the difference in cardiac catheterization use between men and women with weak indications was statistically nonsignificant (16.5% in women [CI, 15.0% to 17.9%] vs. 18.0% in men [CI, 16.8% to 19.2%]) ($P = 0.096$). However, we observed modest sex differences in cardiac catheterization use among patients with equivocal indications for the procedure (39.4% in women [CI, 38.8% to 41.9%] vs. 42.5% in

men [CI, 41.7% to 43.0%]) ($P < 0.001$). When patients with equivocal indications were further divided into those who met class IIa criteria; class IIb criteria; and those who did not meet class I, class II, or class III criteria, women had lower risk-standardized rates of cardiac catheterization than men, although these differences were similarly modest. Findings were similar when we evaluated the composite end point of cardiac catheterization and refusal of cardiac catheterization during hospitalization (**Table 3**).

DISCUSSION

Crude sex differences in cardiac catheterization use among Medicare patients after acute myocardial infarction are explained mostly by sex differences in demographic, clinical, and hospital characteristics. Residual sex differences in procedure use cannot be attributed to a broad pattern of lower rates of cardiac catheterization among women; rather, they vary by procedure appropriateness. Risk-standardized rates of cardiac catheterization use for women and men with strong indications for the procedure are similar, whereas rates were only slightly lower among women with equivocal indications. Thus, sex differences in the use of cardiac catheterization do not reflect sex-associated disparities in appropriate clinical treatment.

Earlier studies have reported conflicting findings concerning sex differences in cardiac catheterization use. Laouri and colleagues (26) reported that women were less likely to undergo "necessary" cardiac catheterization (as identified by RAND Delphi appropriateness methods) than similarly classified men (adjusted odds ratio, 0.54). The discordance between these data and our findings may reflect Laouri's study sample, which consisted of patients who had positive results on exercise stress tests; our study, on the other hand, evaluated patients hospitalized with confirmed myocardial infarction. The heterogeneity of patient ages and clinical conditions in Laouri's study sample may have increased physician uncertainty about the diagnosis of coronary disease, whereas our patients were a uniformly elderly cohort with documented disease. Socioeconomic factors may also contribute to the difference in findings. Our study included patients who had a common payer and who were drawn from a diverse spectrum of centers, whereas Laouri's study group included patients who were uninsured and were drawn primarily from public hospitals.

In contrast, both Kilaru and colleagues (18) and Wong and colleagues (25) reported no statistically significant sex differences in cardiac catheterization use after myocardial infarction and stratification of patients according to their appropriateness for the procedure. The absence of a sex difference among patients with equivocal indications in the Kilaru and Wong studies may reflect the small study samples ($n = 439$ and $n = 1133$) and centers selected for study (one public hospital in the Kilaru study and seven managed-care hospitals in the Wong study).

Our findings of similar rates of cardiac catheterization in men and women with strong indications—both for and against the procedure—are reassuring. These findings, when considered with data indicating that sex differences in cardiac catheterization use do not vary by sex of the physician (31), suggest that it is inaccurate to attribute sex differences in cardiac procedure use to gender bias by male physicians toward female patients. The large reduction in sex differences in cardiac procedure use observed after multivariable adjustment indicates that more conventional clinical characteristics may explain most of the observed variation. Sex of the patient may influence use of cardiac catheterization among patients with equivocal indications; however, because the role of cardiac catheterization in pa-

Table 3. **Crude and Risk-Standardized Rates of Cardiac Catheterization***

Variable	All Patients (n = 143 444)	Men (n = 72 975)	Women (n = 70 469)	Risk Ratio: Women/Men	P Value
	← % →				
Crude rate					
Overall	41.2	46.5 (46.2–46.9)	35.7 (35.3–36.0)	0.77 (0.75–0.78)	<0.001
Appropriateness					
Strong (ACC/AHA class I)	44.4	49.3 (48.8–49.9)	39.6 (39.1–40.1)	0.80 (0.79–0.82)	0.001
Equivocal	41.2	47.5 (47.0–48.0)	34.2 (33.7–34.7)	0.72 (0.71–0.73)	0.001
ACC/AHA class IIA	36.2	42.6 (41.9–43.2)	29.1 (28.4–29.7)	0.68 (0.66–0.70)	0.001
ACC/AHA class IIB	49.3	54.9 (53.6–56.3)	43.4 (42.0–44.7)	0.79 (0.76–0.82)	0.001
Not classified	48.4	54.7 (53.6–55.7)	41.0 (39.8–42.1)	0.75 (0.72–0.77)	0.001
Weak (ACC/AHA class III)	17.4	20.3 (19.1–21.4)	14.0 (12.9–15.0)	0.69 (0.63–0.76)	0.001
Risk-standardized rate					
Overall	41.2	41.9 (41.6–42.4)	40.3 (40.0–40.8)	0.96 (0.95–0.98)	<0.001
Appropriateness					
Strong (ACC/AHA class I)	44.4	44.6 (44.0–45.3)	44.1 (43.2–44.9)	0.99 (0.96–1.01)	>0.2
Equivocal	41.2	42.5 (41.7–43.0)	39.4 (38.8–41.9)	0.93 (0.91–0.95)	<0.001
ACC/AHA class IIA	36.2	37.2 (36.6–38.1)	34.6 (33.9–35.4)	0.93 (0.90–0.96)	<0.001
ACC/AHA class IIB	49.3	50.7 (48.9–52.5)	47.4 (45.3–49.4)	0.93 (0.88–0.98)	0.014
Not classified	48.4	50.2 (48.9–51.4)	45.8 (44.0–47.5)	0.91 (0.87–0.95)	<0.001
Weak (ACC/AHA class III)	17.4	18.0 (16.8–19.2)	16.5 (15.0–17.9)	0.92 (0.82–1.01)	0.096

* Reported as rates and risk ratios with 95% CIs. ACC/AHA = American College of Cardiology/American Heart Association (1996).

tients with equivocal indications is unclear, we cannot conclude that quality of care is poor on the basis of sex of the patient. Some of these patients, particularly those who meet class IIb criteria, are unlikely to obtain a benefit from cardiac catheterization that would exceed the procedure-related risks (37).

Modest sex differences in cardiac catheterization use among patients with equivocal indications suggest that sex of the patient may slightly influence physician decision making when diagnostic or therapeutic options are unclear. Women report different cardiac symptoms than men (38), and these differences in presentation may complicate decision making in the absence of definitive evidence of ischemia or reinfarction. Physicians may have lower prior estimates of the utility of cardiac catheterization in women because women have a higher comorbidity burden and because women who undergo cardiac catheterization are less likely to have evidence of coronary disease, and less severe disease, than men (39–41). The small observed difference may also reflect model misspecification or residual confounding.

Some aspects of our study merit particular attention. First, patient appropriateness for cardiac catheterization was determined by applying ACC/AHA guidelines for cardiac catheterization to data elements available in the CCP in a manner similar to that of Guadagnoli and colleagues (30). Thus, we could not identify patients who may have had a strong indication for cardiac catheterization because of a mechanical defect (for example, ventricular septal defect or left ventricle aneurysm), although we expect this to be a small population. In addition, the ACC/AHA guidelines reflect both a synthesis of professional consensus and evidence and, thus, may differ from a strict evidence-based evaluation of cardiac catheterization use. Unlike others (42), however, our purpose was not to assign patients to a definitive standard of care (for example, all patients with strong indications should have cardiac catheterization) but rather to stratify our cohort into three groups for whom the benefits of cardiac catheterization were clear, unclear, or absent according to professional practice guidelines. Because we did not have access to Medicare Part B data, we could not determine whether patients had office-based cardiac catheterizations. We relied on data obtained from a retrospective abstraction of medical records and thus may have missed undocumented clinical indications for cardiac catheterization among patients with equivocal indications. Because of the importance of clinical events that underlie indications in our study (for example, recurrent ischemia, shock, persistent angina, hepatic failure), we consider this unlikely. We evaluated Medicare fee-for-service beneficiaries who were hospitalized with myocardial infarction between 1994 and 1996, and it is unclear whether procedure appropriateness may be a factor for sex variations in cardiac catheterization use in patients younger than 65 years of age, Medicare patients enrolled in managed care plans, cardiac catheterizations not associated with myocardial infarction, or contemporary practice. Finally, the low rate of procedure use, small number of patients, and the small absolute sex difference in procedure use among patients in the weak indication group made it difficult to draw inferences about sex differences in this population.

In conclusion, our data indicate that the use of cardiac catheterization among elderly men and women hospitalized with myocardial infarction varies depending on the appropriateness of the procedure and is not likely to be attributable to gender bias. The lack of sex differences in cardiac catheterization use among patients with strong indications suggests that sex of the patient does not influence physician decision making in the presence of clear clinical evidence of the value of a procedure. However, the modest sex differences in procedure use among patients with equivocal indications suggest that sex of the patient may influence decision making, but only when treatment indications are equivocal, and even then, the effect is small.

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