Sex Differences in Access to Coronary Revascularization after Cardiac Catheterization: Importance of Detailed Clinical Data

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Background: **Although some studies suggest that access to cardiac procedures may differ by sex, others have found no evidence of gender bias in cardiac care.**

Objective: **To study rates of percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG) surgery in men and women after cardiac catheterization.**

Design: **Cohort study with prospective data collection.**

Setting: **Alberta, Canada.**

Patients: **Persons undergoing cardiac catheterization between 1 January 1995 and 31 December 1998 (*n* = 21 816).**

Measurements: **The occurrence of revascularization procedures (PCI or CABG) in the year after cardiac catheterization was measured. Unadjusted revascularization rates, partially adjusted rates (adjusted for clinical variables available in most databases, including administrative databases), and fully adjusted rates (additionally adjusted for extent of coronary artery disease and ejection fraction) were also evaluated.**

Results: **The unadjusted relative risk was 0.67 (95% CI, 0.65 to 0.71) for the end point of any revascularization in women relative to men. The relative risk increased to 0.69 (CI, 0.66 to 0.72) with partial adjustment and to 0.98 (CI, 0.94 to 1.03) with full adjustment, indicating equivalent access to revascularization for men and women. For PCI, the corresponding relative risks were 0.77 (CI, 0.73 to 0.82), 0.84 (CI, 0.80 to 0.89), and 1.02 (CI, 0.96 to 1.08). For CABG surgery, the relative risks were 0.54 (CI, 0.51 to 0.58), 0.51 (CI, 0.48 to 0.55), and 0.93 (CI, 0.87 to 1.01).**

Conclusions: **In Alberta, Canada, clinical variables fully explain sex differences in rates of revascularization after cardiac catheterization, and misleading conclusions would arise without full adjustment for clinical differences between men and women. Extreme caution is needed in interpreting reports on access to care that use sparsely detailed clinical data sources.**

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Reports of sex differences in the likelihood of undergoing cardiac procedures have led to suggestions of gender bias in cardiac care decision making (1–14). Other proposed explanations for the variation in use of cardiac procedures between sexes include differing patient preferences or differing clinical characteristics (for example, smaller coronary vessels in women).

Earlier studies did not unanimously find sex differences in cardiac procedure rates; some studies reported equivalent procedure rates for men and women (15–21). The inconsistency across studies may be related to differences in geographic regions and health systems. However, another possible explanation is that many earlier studies evaluated highly selected patient samples that may not reflect processes of care at a population level. Yet another possible explanation is that the published studies on this issue have used various data sources, ranging from highly detailed data from clinical trials to sparsely detailed administrative data.

The Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH) is a population-based registry that captures detailed clinical information on all adult patients undergoing cardiac catheterization in the province of Alberta, Canada (22). The clinically detailed data generated by APPROACH provide a unique opportunity to study sex differences in access to revascularization after cardiac catheterization without the limitations of a nonrepresentative study sample or insufficiently detailed clinical data. Furthermore, the detailed APPROACH data allow us to assess whether comorbid conditions, extent of coronary disease, and ejection fraction account for or explain any observed sex differences in access to revascularization procedures—percutaneous coronary intervention (PCI) and coronary artery bypass graft (CABG) surgery.

Using a two-step process, we statistically adjusted crude (unadjusted) rates of cardiac revascularization for men and women in the year following cardiac catheterization. The first (partial) adjustment was based on baseline clinical variables that are routinely available in most

Context

Women are less likely to be offered therapeutic cardiac procedures than men; however, the reason—gender bias or clinical factors—is unknown.

Contribution

This study of coronary revascularization procedures during the year after catheterization compared men and women with the same extent of coronary artery disease and ejection fraction. The rate of coronary revascularization was the same in men and women.

Implications

The sex differences in cardiac procedure rates after catheterization appear to reflect appropriate decisions rather than gender bias. However, sex-based differences in catheterization rates remain unexplained.

–The Editors

databases, including administrative databases. The second (full) adjustment also controlled for extent of coronary disease and ejection fraction, variables that are uniquely available for a large unselected patient population in APPROACH data.

METHODS

Data Source and Variables

The APPROACH database is an inception cohort database that captures clinical information on all patients undergoing cardiac catheterization in Alberta, Canada (22). This province has a population of approximately 2.8 million persons, of whom 10% identify themselves as ethnic minorities (3.5% are of Chinese ethnicity, 2% are of South Asian ethnicity, 1% are black, and 4.5% are aboriginal inhabitants). In 1996, median individual income levels for postal code–defined regions ranged from $12 000 to $37 000 Canadian per year. Sixty-seven percent of Albertans older than 20 years of age have a high school diploma, and 25% have some university-level education.

Patients in APPROACH are followed longitudinally for assessment of long-term outcomes after cardiac catheterization. Clinical risk variables recorded at the time of cardiac catheterization are age, sex, diabetes mellitus, cerebrovascular disease, congestive heart failure, chronic pulmonary disease, elevated creatinine level (≥200 mmol/L [≥22.62 g/L]), dialysis status, hyperlipidemia, hypertension, liver or gastrointestinal disease, malignancy or metastatic disease, previous myocardial infarction, previous thrombolytic therapy for myocardial infarction, and peripheral vascular disease. The indication for catheterization is recorded in one of four categories: myocardial infarction within 8 weeks of catheterization, unstable angina, stable angina, or other (for example, arrhythmias without associated angina, or study protocols). The results of cardiac catheterization, including extent of coronary disease and left ventricular ejection fraction, are also recorded. We graded extent of coronary disease according to six categories: normal or near normal, one- to two-vessel disease, two-vessel disease with proximal left anterior descending artery involvement, three-vessel disease, three-vessel disease with proximal left anterior descending artery involvement, or left main disease. A diseased vessel was one that contained a lesion involving more than 50% of the vessel diameter. Left ventricular ejection fraction was graded according to five categories: greater than 50%, 30% to 50%, less than 30%, ventriculography not done (usually because of renal insufficiency or severely depressed cardiac function), and data missing. The APPROACH database accurately captures the occurrence of revascularization procedures in Alberta hospitals and the time to revascularization after cardiac catheterization.

We analyzed data from patients undergoing cardiac catheterization from 1995 through 1998, with follow-up data through 1999. The Ethics Review Boards of the University of Calgary and the University of Alberta, Canada, approved the APPROACH study protocol.

Statistical Analysis

We performed a chi-square test and two-sample *t*-tests to compare the clinical characteristics of men and women undergoing catheterization. Chi-square tests and log-rank tests were used to compare the unadjusted proportions of men and women having revascularization procedures within 1 year after cardiac catheterization.

We then used multivariable Cox proportional hazards analyses to control revascularization rates for differences in clinical characteristics between men and women undergoing catheterization. For these analyses, we modeled time to 1) any revascularization procedure, 2) PCI, and 3) CABG surgery, with follow-up to 1 year. We initially calculated crude relative risks for procedures for

Table 1. **Characteristics of Men and Women Undergoing Cardiac Catheterization in Alberta, Canada, 1995–1998***

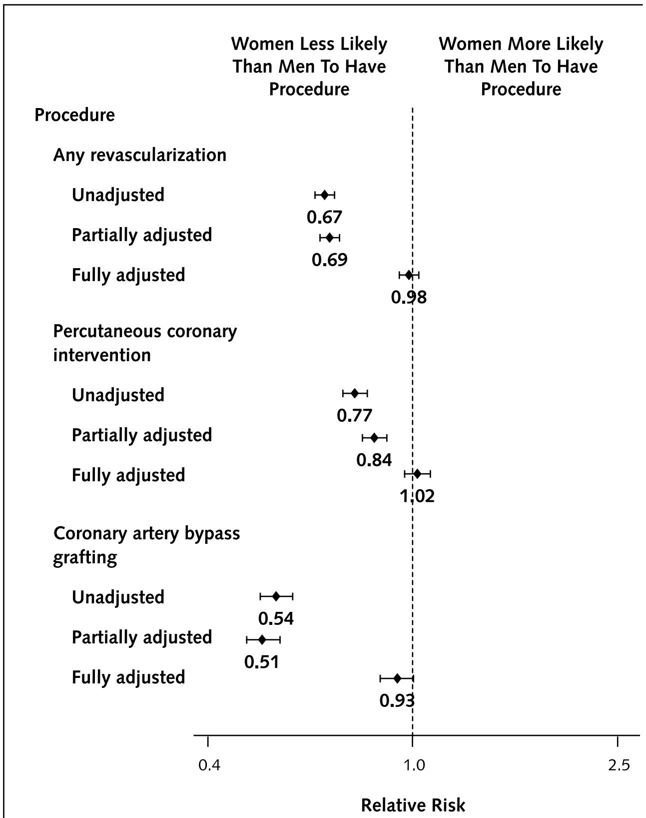
Characteristic	Women (*n* = 6407)	Men (*n* = 15 409)	*P* Value†
Mean age, *y*	64.7	61.5	<0.001
Hypertension, %	58.6	48.1	<0.001
Previous myocardial infarction, %	41.5	53.6	<0.001
Hyperlipidemia, %	41.5	43.0	0.03
Diabetes mellitus, %	20.6	17.2	<0.001
Congestive heart failure, %	16.3	13.2	<0.001
Chronic lung disease, %	10.7	8.1	<0.001
Previous thrombolytic therapy, %	9.6	11.8	<0.001
Peripheral vascular disease, %	7.0	7.1	>0.2
Cerebrovascular disease, %	6.7	5.3	<0.001
Liver disease, %	3.6	3.0	0.05
Cancer, %	3.6	3.0	0.03
Creatinine level ≥200 mmol/L (≥22.62 g/L), %	2.1	2.4	0.14
Dialysis dependent, %	1.1	1.4	>0.2
Indication for catheterization, %			<0.001
Myocardial infarction	23.0	28.0	
Stable angina	32.9	28.7	
Unstable angina	29.5	31.5	
Other	14.6	11.8	
Left ventricular ejection fraction, %			<0.001
>50%	62.8	52.6	
30% to 50%	16.2	23.3	
<30%	3.8	5.6	
Ventriculography not done	13.0	13.9	
Information missing	4.2	4.5	
Extent of coronary disease, %			<0.001
Normal or near normal	33.0	14.1	
One- or two-vessel disease	23.9	23.3	
Two-vessel disease with PLAD involvement	13.3	16.2	
Three-vessel disease	14.1	21.7	
Three-vessel disease with PLAD involvement	9.8	15.7	
Left main disease	5.8	9.0	

* PLAD = proximal left anterior descending artery.
† *P* values were calculated by using the chi-square test for categorical variables and the *t*-test for age.

women relative to men and then sequentially modeled two sets of variables. First, for the partially adjusted model, we used a set of clinical variables (age, indication for cardiac catheterization, cardiac history, and the comorbidity variables listed earlier) that would generally be available in most administrative databases (throughout the paper, we call this initial step "partial adjustment"). Second, for the fully adjusted model, we added two clinical variables, left ventricular ejection fraction and extent of coronary disease, that are uniquely available at a population level in the clinically detailed APPROACH database. The relative risk for women compared with men was the variable of interest for each of the models generated. We calculated and plotted risk-adjusted time-to-revascularization curves for men and women by applying the corrected group prognosis method to the proportional hazards models that generated fully adjusted relative risks (23).

By plotting $\log[-\log S(t)]$ versus t and log(t) for all of the above models, we found that the proportional hazards assumption was appropriate for all variables included in the models, except the variable of indication for cardiac catheterization. Therefore, we handled cardiac catheterization as a stratification variable in our models. To assess model performance, we also plotted both martingale and deviance residuals for individual observations and found that none of the observations were widely deviant (that is, almost all deviance residuals were between −1.96 and 1.96). We examined influential observations by measuring the changes in the coefficients after dropping each observation from the data. For sex, the most influential observations changed the coefficient by less than 5% of the standard error. The software product used to perform data analyses was S-PLUS 5 for Linux, version 5.1 (Insightful Corp., Seattle, Washington).

Figure 1. **Relative risks for undergoing revascularization procedures in women compared with men.**



Role of the Funding Sources

The funding sources had no role in the design, conduct, or reporting of this study.

RESULTS

A total of 21 816 patients underwent cardiac catheterization in Alberta between 1 January 1995 and 31 December 1998. Of these patients, 15 409 (70.6%) were men and 6407 (29.4%) were women. Within 1 year after catheterization, 8488 of the 15 409 men (55.1%) had undergone a revascularization procedure (PCI or CABG surgery) compared with only 2574 of the 6407 women (40.2%) ($P < 0.001$). The proportion having undergone PCI at 1 year was 32.2% for men versus 26.1% for women ($P < 0.001$). The proportion having CABG surgery by 1 year after catheterization was 22.9% for men and only 14.0% for women ($P < 0.001$). In a proportional hazards analysis, the corresponding crude relative risk (that is, the likelihood) for having any revascularization procedure for women compared with men was 0.67 (95% CI, 0.65 to 0.71). For PCI and CABG surgery, the corresponding relative risks were 0.77 (CI, 0.73 to 0.82) and 0.54 (0.51 to 0.58), respectively. Thus, in relative terms, women were 33% less likely to undergo any revascularization procedure, 23% less likely to undergo PCI, and 46% less likely to undergo CABG surgery than were men.

Clinical Characteristics

Clinical characteristics of men and women differed (**Table 1**). Men tended to be younger and had fewer comorbid conditions, including a lower prevalence of chronic lung disease, cerebrovascular disease, hypertension, diabetes mellitus, liver disease, and congestive heart failure. However, men were more likely to have had a previous myocardial infarction. Men were also more likely than women to have acute indications for their catheterization procedures, such as myocardial infarction or unstable angina. The results of catheterization revealed more extensive coronary artery disease in men than in women, with a substantially higher proportion of men having three-vessel or left main disease. Left ventricular ejection fraction also tended to be lower for men than for women. **Appendix Table 1** shows the relationship between each of the clinical variables studied and the likelihood of undergoing revascularization procedures in men and women.

Crude and Adjusted Relative Risks for Revascularization

To account for the clinical differences shown in **Table 1,** we used Cox proportional hazards models to adjust relative risks for revascularization in women and men. For the end point of any revascularization procedure, the relative risk for women relative to men was 0.67 (CI, 0.65 to 0.71) in the unadjusted analysis, 0.69 (CI, 0.66 to 0.72) in the partially adjusted analysis, and 0.98 (CI, 0.94 to 1.03) in the fully adjusted analysis (**Figure 1**). Extent of coronary disease explained almost all of the shift in the relative risk in the full-adjustment model; the fully adjusted model without extent of coronary disease yielded a relative risk of only 0.69 (CI, 0.66 to 0.72) for women compared with men.

For PCI, the relative risks for women compared with men were 0.77 (CI, 0.73 to 0.82) in the unadjusted analysis, 0.84 (CI, 0.80 to 0.89) after partial adjustment, and 1.02 (CI, 0.96 to 1.08) after full adjustment. For CABG surgery, the relative risks for women were 0.54 (CI, 0.51 to 0.58) in the unadjusted model, 0.51 (CI, 0.48 to 0.55) after partial adjustment, and 0.93 (CI, 0.87 to 1.01) after full adjustment. In analysis of PCI and of CABG surgery, extent of coronary disease explained almost all of the upward shift in the relative risks.

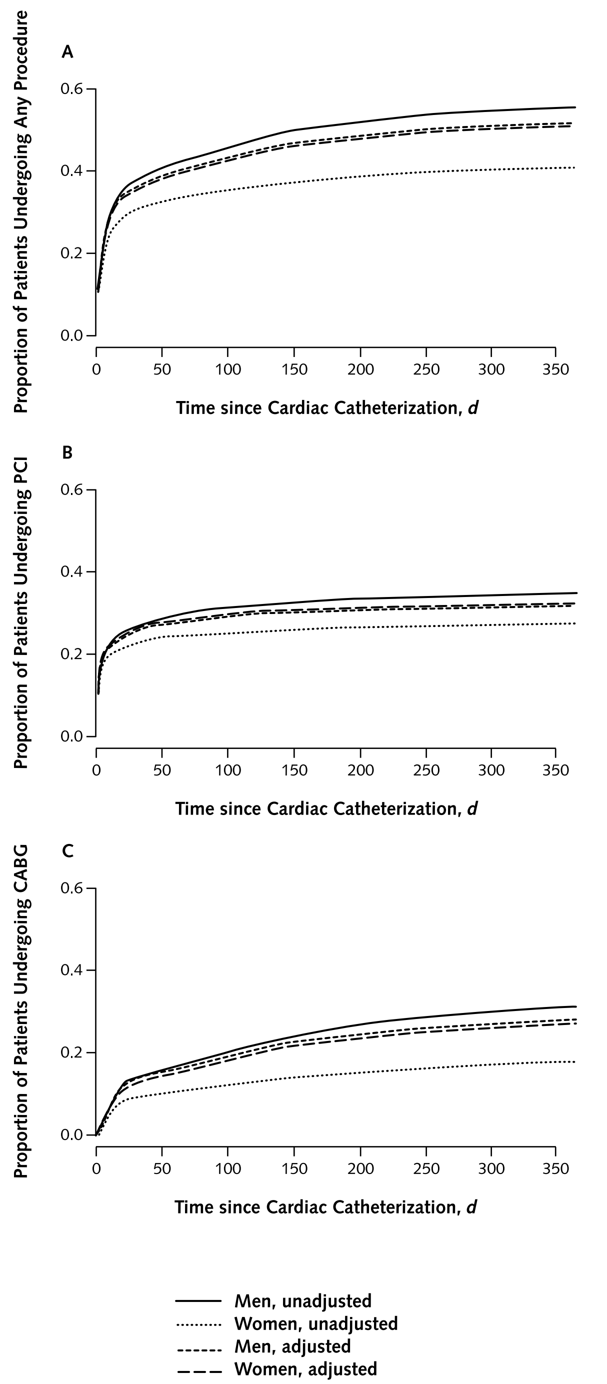
We performed additional analyses to explore the potential influence of individual hospitals' treatment styles. First, by adding hospital dummy variables to each of the three fully adjusted models, we obtained results that were almost identical to those described earlier for models without hospital dummy variables. Relative risks for the model of any revascularization and the PCI model were identical in analyses that included and those that excluded hospital dummy variables. For the CABG surgery model, the relative risk for women relative to men differed only by 0.004 between models, and statistical significance did not change. In addition, none of the interaction terms between hospital variables and the sex variable in our models were significant. Therefore, these findings demonstrate that the relationship between patient sex and access to revascularization procedures is not confounded or modified by hospital effects.

In another confirmatory analysis, we separated patients into acute and nonacute groups on the basis of indication for catheterization. Separate modeling analyses revealed that all fully adjusted relative risks for women compared with men did not significantly differ from 1.0 (that is, these results were consistent with the findings of our overall analysis). **Appendix Table 2** shows the proportional hazards models used for full risk adjustment of procedure rates.

Adjusted Revascularization Rates

Figure 2 shows crude and fully adjusted cumulative revascularization curves. The crude (unadjusted) curves suggest that men are more likely than women to undergo revascularization in the year after cardiac catheterization. However, full adjustment shows that men and women are equally likely to undergo revascularization procedures, PCI, and CABG surgery during this time frame. The adjusted proportion of patients having undergone any revascularization procedure at 1 year after censoring of deaths was 51.1% for women and 51.5% for men ($P > 0.2$). The corresponding proportions for

Figure 2. **Crude (unadjusted) and fully adjusted cumulative revascularization curves for men and women.**



A. Curves for any revascularization procedure. **B.** Curves for percutaneous coronary intervention (*PCI*). **C.** Curves for coronary artery bypass graft (*CABG*).

Table 2. **Details of Earlier Published Studies on Adjusted Rates of Revascularization after Cardiac Catheterization, according to Sex***

Study (Reference), Year	Country	Type of Data	Key Findings
Bearden et al. (2), 1994	United States	Detailed clinical data (from a trial)	Women less likely to undergo CABG surgery and PCI
Krumholz et al. (3), 1992	United States	Detailed clinical data†	Women less likely to undergo CABG surgery but male and female rates similar for PCI
Dong et al. (4), 1998	United Kingdom	Household survey data	Women less likely to have undergone or be waiting for cardiac surgery
Naylor and Levinton (6), 1993	Canada	Detailed clinical data (queue data)†	Women less likely to undergo CABG surgery and PCI (difference greatest for CABG surgery)
Ayanian and Epstein (8), 1991	United States	Administrative data	Women less likely to undergo CABG surgery and PCI (between-sex difference greater for each procedure than for catheterization)
Steingart et al. (9), 1991	United States	Detailed clinical data (from a trial)†	No sex differences in likelihood of undergoing CABG surgery after catheterization
Jaglal et al. (11), 1994	Canada	Administrative data	Women less likely to undergo CABG surgery and PCI (difference greater for CABG than for catheterization)
Chandra et al. (13), 1998	United States	Cardiac registry data (some detail)	Women less likely to undergo CABG surgery; PCI rates were also lower for women but were tied to catheterization rates
Bickell et al. (14), 1992	United States	Detailed clinical data†	Women less likely to be referred for CABG surgery after catheterization
Leape et al. (16), 1999	United States	Detailed clinical data (from patient records)†	No sex differences in likelihood of undergoing "necessary" CABG or PCI (RAND method)
Lincoff et al. (17), 1993	United States	Detailed clinical data (from a trial)†	No sex differences in likelihood of undergoing in-hospital CABG or PCI after myocardial infarction
Raine et al. (18), 1999	United Kingdom	Detailed clinical data (from patient records)†	No sex differences in likelihood of undergoing CABG or PCI after myocardial ischemia or infarction
Roeters van Lennep et al. (19), 2000	Netherlands	Detailed clinical data†	No sex differences in likelihood of undergoing CABG or PCI after catheterization
Miller et al. (20), 2001	United States	Detailed clinical data†	No sex differences in likelihood of undergoing CABG or PCI after catheterization
Bell et al. (21), 1995	United States	Detailed clinical data†	Women less likely to undergo CABG surgery but more likely to undergo PCI after catheterization

* CABG = coronary artery bypass graft; PCI = percutaneous coronary intervention.
† The data used contained information on extent of coronary disease.

PCI and CABG, respectively, were 32.3% for women and 31.9% for men ($P > 0.2$) and 27.7% for women and 29.0% for men ($P = 0.08$).

Discussion

Although crude and partially adjusted relative risks suggest that women are less likely than men to have a revascularization procedure in the year after cardiac catheterization, a fully adjusted analysis indicates that the revascularization rates between sexes are equivalent after correction for differences in extent of coronary disease. Thus, our findings do not support the existence of a sex bias after cardiac catheterization in the Canadian province that we studied.

These findings emphasize the value of clinically rich data sources for representative patient samples and point to the need for extreme caution in interpreting reports on access issues that use sparsely detailed data sources. Our partial adjustment analysis used variables that were prospectively collected but that could have alternatively been derived from available administrative databases. Despite the prospective collection of these data, our analysis still yielded misleading results. We found an explanation for sex differences in procedure rates only because information on extent of coronary disease was available.

Iezzoni and colleagues (24) recently evaluated sex differences in cardiac procedure use after myocardial infarction using 10 severity measurement systems, 4 of which used medical record data (clinical data sources) and 6 of which used administrative data. These investigators reported that the finding of reduced access to cardiac procedures for women compared with men was robust and entirely insensitive to the severity measurement system used. However, the 4 clinical data sources used (2 based on the MedisGroups system [25, 26] and 2 based on the Acute Physiology and Chronic Health

Evaluation [APACHE] [27, 28]) did not contain information on extent of coronary disease. Had such information been available, Iezzoni and colleagues might have found that sex differences in the use of CABG and PCI are affected by the type of data used for analysis.

Some investigators have proposed that all potential sex differences in access to cardiac procedures occur *before* cardiac catheterization and that the delivery of care and access to catheterization are similar for men and women *after* cardiac catheterization or the firm diagnosis of coronary artery disease. However, this is not an entirely unanimous conclusion across studies. As shown in **Table 2,** some studies have suggested that men and women have equal access to revascularization after cardiac catheterization (9, 16-21); meanwhile, several other studies have found evidence of less access to revascularization for women because of differences that probably arose after cardiac catheterization (2–4, 6, 8, 11, 13, 14). This discrepancy may be caused by differences in the geographic regions and health systems studied. Another possible explanation is the different methods used across studies and the varying clinical detail in the data sources (**Table 2**).

Growing evidence suggests that coronary disease presents differently in women than in men. In three recent reports (29–31), sex differences were found in the presenting symptoms associated with coronary artery disease. Our data also show that women and men undergoing cardiac catheterization differ considerably; women had a higher burden of comorbid illness but, perhaps paradoxically, less severe coronary disease (**Table 1**). Although the sex differences in our study may be related in part to referral bias or other selection factors before catheterization, they may also be due to fundamental sex differences in the clinical presentation of coronary artery disease. These differences in clinical presentation appear to largely contribute to sex differences in the delivery of cardiac care.

One limitation of our study is that we had detailed clinical data only on treatment decisions after cardiac catheterization. Although the APPROACH data allowed us to explain sex differences in revascularization rates after diagnostic catheterization, there is certainly a need for further research. Future studies should use detailed clinical databases to examine sex differences in management earlier in the clinical presentation of coronary heart disease, before cardiac catheterization, when decisions on cardiac testing are first being made. Data on the number of cardiac catheterizations according to sex, combined with Canadian census data, permit us to determine that the unadjusted population rates of cardiac catheterization in Alberta are 410.9 procedures per 100 000 men and 166.2 procedures per 100 000 women. This marked between-sex difference in unadjusted population rates of catheterization suggests that women in Alberta are far less likely than men to undergo catheterization. However, as with our findings for revascularization rates, it is conceivable that the marked differences in catheterization rates might similarly be explained by sex differences in burden of disease and early clinical presentation.

A second obvious limitation of our study is that we evaluated only one patient population treated in one health care system. Thus, access to revascularization may differ by sex elsewhere. Notably, rates of invasive cardiac procedures are generally lower in Canada than in the United States—a between-country difference that may not be uniform across sexes. A third limitation of our report is that we cannot resolve the issue of determining the optimal rate of cardiac procedures. In this regard, future interregional or international comparative studies linking procedure rates to outcome (overall and by sex) may provide insights into the procedure rates that optimize outcomes.

Nevertheless, our results provide additional evidence that the evaluation of differences in access to cardiac procedures requires detailed clinical information. In this study, misleading conclusions would have been reached regarding sex differences in access to revascularization procedures had it not been possible to control for extent of coronary disease. Researchers and readers should use extreme caution when interpreting the results of past and future studies that use sparsely detailed clinical data or nonrepresentative patient samples.

APPENDIX: MEMBERS OF THE APPROACH STEERING COMMITTEE

Vladimir Dzavik, MD (*Chair*), Edmonton; L. Brent Mitchell, MD, Calgary; Stephen Archer, MD, Edmonton; Michelle M. Graham, MD, Edmonton; Arvind Koshal, MD, Edmonton; Andrew Maitland, MD, Calgary; Michael Curtis, MD, Calgary; William Hui, MD, Edmonton; Merril L. Knudtson, MD, Calgary; William A. Ghali, MD, MPH, Calgary; Colleen M. Norris, MSc, Edmonton; and Diane Galbraith, BN, Calgary, Canada.

Appendix Table 1. **Patients Undergoing Revascularization Procedures within 1 Year, according to Clinical Characteristics and Sex***

Characteristic	Patients Undergoing Any Procedure		Patients Undergoing PCI		Patients Undergoing CABG	
	Men	Women	Men	Women	Men	Women
	←		%			→
Hypertension						
No	54.0	36.8	33.6	25.0	20.4	11.8
Yes	56.2	42.6	30.7	26.9	25.6	15.7
Previous myocardial infarction						
No	49.5	31.7	27.0	19.3	22.5	12.3
Yes	59.9	52.1	36.7	35.7	23.2	16.4
Hyperlipidemia						
No	51.3	36.6	30.3	23.7	21.0	12.9
Yes	60.1	45.3	34.8	29.6	25.4	15.7
Diabetes mellitus						
No	54.9	38.4	33.0	25.6	21.9	12.8
Yes	56.0	47.1	28.6	28.2	27.5	18.9
Congestive heart failure						
No	56.3	39.9	33.6	26.7	22.7	13.2
Yes	47.3	41.6	23.2	23.3	24.1	18.3
Chronic lung disease						
No	55.4	40.4	32.7	26.2	22.7	14.2
Yes	51.4	38.5	26.3	25.5	25.1	13.0
Previous thrombolysis						
No	53.5	38.1	30.0	24.1	23.5	13.9
Yes	66.8	60.3	48.4	45.1	18.3	15.2
Previous PCI						
No	54.4	39.0	31.3	25.0	23.1	14.1
Yes	60.3	53.8	38.6	39.9	21.6	13.8
Peripheral vascular disease						
No	55.3	40.1	32.8	26.4	22.5	13.6
Yes	52.5	41.8	24.1	22.0	28.3	19.8
Cerebrovascular disease						
No	55.2	39.8	32.6	26.2	22.7	13.5
Yes	52.4	45.7	25.9	24.6	26.6	21.1
Previous CABG surgery						
No	56.3	40.2	32.8	26.0	23.5	14.2
Yes	42.5	38.8	26.1	29.4	16.4	9.4
Liver disease						
No	55.1	40.2	32.2	26.2	22.9	14.0
Yes	54.7	39.0	33.3	24.6	21.4	14.5
Cancer						
No	55.1	40.2	32.3	26.0	22.9	14.2
Yes	54.4	40.8	30.8	30.3	23.6	10.5
Creatinine level ≥ 200 mmol/L (≥22.62 g/L)						
No	55.2	40.1	32.4	26.2	22.8	13.9
Yes	48.9	43.3	23.3	23.9	25.7	19.4
Dialysis dependent						
No	55.3	40.2	32.3	26.2	23.0	14.0
Yes	40.7	41.1	24.9	20.5	15.8	20.5
Indication for catheterization						
Myocardial infarction	66.8	60.2	47.0	45.1	19.9	15.2
Stable angina	50.0	31.6	24.6	17.9	25.5	13.7
Unstable angina	60.0	43.8	34.6	28.6	25.4	15.2
Other	28.8	17.7	11.8	7.3	17.0	10.5
Left ventricular ejection fraction						
>50%	55.4	37.8	34.7	25.4	20.7	12.4
30% to 50%	58.4	47.7	29.1	27.5	29.3	20.2
<30%	38.7	33.2	17.1	18.4	21.5	14.8
Ventriculography not done	57.0	48.1	39.1	34.0	17.9	14.2
Information missing	54.3	41.8	31.9	27.9	22.4	13.9
Coronary anatomy						
Normal or near normal	3.0	0.8	1.8	0.5	1.2	0.3
One- to two-vessel disease	53.9	48.1	50.6	45.2	3.3	2.9
Two-vessel disease with PLAD involvement	68.5	68.1	54.2	56.8	14.2	11.2
Three-vessel disease	65.1	64.0	33.5	33.7	31.6	30.3
Three-vessel disease with PLAD involvement	65.1	62.7	21.3	23.8	43.8	38.9
Left main disease	74.0	71.2	8.2	8.3	65.8	62.9

* CABG = coronary artery bypass graft; PCI = percutaneous coronary intervention; PLAD = proximal left anterior descending artery.

Appendix Table 2. **Models Used To Obtain Fully Adjusted Relative Risks for Revascularization Procedures for Women Compared with Men***

Characteristic	Coefficient and Relative Risk for Women (95% CI)					
	Any Procedure		PCI		CABG	
	Coefficient	RR (95% CI)	Coefficient	RR (95% CI)	Coefficient	RR (95% CI)
Female sex	−0.016	0.98 (0.94–1.03)	0.021	1.02 (0.96–1.08)	−0.068	0.93 (0.87–1.01)
Age	−0.007	0.99 (0.99–1.00)	−0.008	0.99 (0.99–0.99)	−0.005	1.00 (0.99–1.00)
Hypertension	−0.006	0.99 (0.96–1.03)	−0.037	0.96 (0.92–1.01)	0.070	1.07 (1.01–1.14)
Previous myocardial infarction	−0.166	0.85 (0.81–0.89)	−0.119	0.89 (0.84–0.94)	−0.245	0.78 (0.73–0.84)
Hyperlipidemia	0.099	1.10 (1.06–1.15)	0.096	1.10 (1.05–1.16)	0.095	1.10 (1.04–1.17)
Diabetes mellitus	−0.084	0.92 (0.88–0.97)	−0.077	0.93 (0.87–0.99)	−0.097	0.91 (0.84–0.98)
Congestive heart failure	−0.120	0.89 (0.83–0.94)	−0.166	0.85 (0.78–0.92)	−0.033	0.97 (0.88–1.06)
Chronic lung disease	0.028	1.03 (0.96–1.10)	−0.033	0.97 (0.88–1.06)	0.139	1.15 (1.03–1.28)
Previous thrombolytic therapy	0.132	1.14 (1.08–1.21)	0.144	1.16 (1.08–1.24)	0.054	1.06 (0.95–1.17)
Peripheral vascular disease	−0.152	0.86 (0.80–0.93)	−0.248	0.78 (0.61–0.87)	−0.061	0.94 (0.85–1.05)
Cerebrovascular disease	−0.051	0.95 (0.87–1.03)	−0.076	0.93 (0.83–1.04)	−0.019	0.98 (0.87–1.11)
Liver disease	0.027	1.03 (0.92–1.15)	0.076	1.08 (0.94–1.24)	−0.034	0.97 (0.81–1.15)
Cancer	−0.048	0.95 (0.86–1.06)	0.006	1.01 (0.88–1.16)	−0.147	0.86 (0.73–1.03)
Creatinine level ≥ 200 mmol/L (≥22.62 g/L)	−0.077	0.93 (0.80–1.07)	−0.242	0.79 (0.64–0.96)	0.168	1.18 (0.96–1.45)
Dialysis dependent	−0.196	0.82 (0.67–1.01)	−0.083	0.92 (0.70–1.20)	−0.317	0.73 (0.53–1.00)
Left ventricular ejection fraction†						
<30%	−0.365	0.70 (0.63–0.77)	−0.232	0.79 (0.68–0.92)	−0.545	0.58 (0.50–0.67)
>50%	0.166	1.18 (1.13–1.24)	0.266	1.30 (1.22–1.39)	0.038	1.04 (0.97–1.12)
Ventriculography not done	0.055	1.06 (0.99–1.13)	0.160	1.17 (1.08–1.28)	−0.082	0.92 (0.83–1.02)
Information missing	0.469	1.60 (1.45–1.76)	0.791	2.21 (1.96–2.48)	−0.117	0.89 (0.75–1.05)
Extent of coronary disease‡						
Normal or near normal	−3.715	0.02 (0.02–0.03)	−3.992	0.02 (0.01–0.03)	−2.034	0.13 (0.09–0.19)
Two-vessel disease with PLAD involvement	0.415	1.51 (1.43–1.60)	0.214	1.24 (1.17–1.32)	1.658	5.25 (4.39–6.28)
Three-vessel disease	0.273	1.31 (1.24–1.39)	−0.345	0.71 (0.66–0.76)	2.378	10.78 (9.15–12.70)
Three-vessel disease with PLAD involvement	0.241	1.27 (1.20–1.35)	−0.801	0.45 (0.41–0.49)	2.661	14.31 (12.14–16.87)
Left main disease	0.552	1.74 (1.62–1.86)	−1.651	0.19 (0.16–0.23)	3.350	28.50 (24.13–33.66)

* CABG = coronary artery bypass graft; PCI = percutaneous coronary intervention; PLAD = proximal left anterior descending artery; RR = relative risk.
† Reference category is ejection fraction of 30% to 50%.
‡ Reference category is coronary disease involving one or two vessels.

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