International Journal for Quality in Health Care 2005; **Volume 17, Number 1**: pp. 37–42 10.1093/intqhc/mzi001

Absence of bias against smokers in access to coronary revascularization after cardiac catheterization

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Abstract

Objective. Many consider smoking to be a personal choice for which individuals should be held accountable. We assessed whether there is any evidence of bias against smokers in cardiac care decision-making by determining whether smokers were as likely as non-smokers to undergo revascularization procedures after cardiac catheterization.

Design. Prospective cohort study.

Subjects and setting. All patients undergoing cardiac catheterization in Alberta, Canada.

Main measures. Patients were categorized as current smokers, former smokers, or never smokers, and then compared for their risk-adjusted likelihood of undergoing revascularization procedures (percutaneous coronary intervention or coronary artery bypass grafting) after cardiac catheterization.

Results. Among 20406 patients undergoing catheterization, 25.4% were current smokers at the time of catheterization, 36.6% were former smokers, and 38.0% had never smoked. When compared with never smokers (reference group), the hazard ratio for undergoing any revascularization procedure after catheterization was 0.98 (95% CI 0.93–1.03) for current smokers and 0.98 (0.94–1.03) for former smokers. The hazard ratio for undergoing coronary artery bypass grafting was 1.09 (1.00–1.19) for current smokers and 1.00 (0.93–1.08) for former smokers. For percutaneous coronary intervention, the hazard ratios were 0.93 (0.87–0.99) for current smokers and 1.00 (0.94–1.06) for former smokers.

Conclusion. Despite potential for discrimination on the basis of smoking status, current and former smokers undergoing cardiac catheterization in Alberta, Canada were as likely to undergo revascularization procedures as catheterization patients who had never smoked.

Keywords: access to health services, cardiac catheterization, coronary revascularization, equity, smoking

Socioeconomic and racial disparities in health care quality have been extensively documented [1–3], and recently, the elimination of disparities in health care has become the objective of several initiatives [4]. While many studies have focused on disparities by sex, race, ethnicity, or socioeconomic status, it has also been suggested that smokers may be a subset of the population who are vulnerable to social stigmatization and unfavorable stereotypes [5]. Smoking cigarettes is viewed by some health professionals as a personal lifestyle choice, and as a result, smokers might be judged by some to be responsible for the health consequences of their behavior [6]. Such a stigmatizing approach toward patients who smoke might incite health care providers to be less enthusiastic about offering invasive and expensive procedures, such as percutaneous coronary intervention or coronary artery bypass grafting. Given the limited financial resources in many health care systems, some have questioned the rationale for offering all available (particularly expensive) medical procedures to individuals with sub-optimal 'health conscious' profiles. Specifically, some have asked whether smokers should be given the same opportunity for coronary artery bypass grafting as non-smokers [6].

To our knowledge, there are no data on the role of smoking as a predictor of unequal access to care. In this study, we used a large and clinically detailed regional registry of patients undergoing cardiac catheterization to assess whether smokers were as likely as non-smokers to undergo coronary revascularization procedures after cardiac catheterization.

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Methods

Data source and variables

The data source for the present study was from APPROACH, the Alberta Provincial Project for Outcome Assessment in Coronary Heart disease, a study that has previously been described in detail [7]. Briefly, APPROACH is an ongoing prospective cohort study of all patients who undergo cardiac catheterization in the Canadian Province of Alberta. Patients are observed longitudinally for assessment of long-term outcomes such as death and subsequent revascularization. At the time of cardiac catheterization, data are collected on age, sex, cerebrovascular disease, heart failure, chronic pulmonary disease, serum creatinine level, renal dialysis, hyperlipidemia, hypertension, liver or gastrointestinal disease, malignancy or metastatic disease, prior coronary artery bypass grafting, prior percutaneous coronary intervention, prior myocardial infarction, prior thrombolytic therapy for myocardial infarction, and peripheral vascular disease. The indication for catheterization is recorded in APPROACH as myocardial infarction, unstable angina, stable angina, or other. The results of cardiac catheterization, including coronary anatomy and left ventricular ejection fraction, are recorded when available (quantitative ejection fraction assessments are not always performed depending on individual patients' clinical status). In describing coronary anatomy, a vessel is considered to be diseased when it contains a lesion with ≥50% stenosis, and extent of disease is categorized into six groups; normal, 1–2 vessel disease, 2 vessel disease with involvement of the proximal left anterior descending artery, 3 vessel disease, 3 vessel disease with involvement of the proximal left anterior descending artery, and left main disease.

Smoking is defined as smoking at least one cigarette a day and this variable is considered to be present if mentioned in a patient's hospital record or reported by the patient at the time of catheterization. The other clinical variables listed above, such as diabetes, are similarly considered to be present if mentioned in a patient's hospital records or reported by the patient when questioned at the time of catheterization. The subsequent occurrence of coronary artery bypass grafting or percutaneous coronary intervention after cardiac catheterization is also captured in the APPROACH database.

Analysis

Patients' smoking status was defined in three categories: current smokers (i.e. smoking at the time of index catheterization), former smokers, and never smokers. We then proceeded to compare the clinical characteristics of these three patient groups using chi-squared tests or analysis of variance, as appropriate. The unadjusted occurrence of coronary revascularization procedures during the 12 months after the index catheterization was compared between the three smoking groups through the log-rank test, and time-to-event curves were calculated and plotted using the cumulative incidence competing risks method [8,9] for the endpoints of (i) coronary artery bypass grafting, (ii) percutaneous coronary intervention, and (iii) any revascularization after catheterization. The time frame of 12 months after catheterization was selected for study because this represents a time interval within which most planned revascularization procedures after catheterization would have occurred. Interventions occurring beyond 12 months are likely to be indicative of new clinical events.

After ensuring appropriateness of the proportional hazards assumption, we then used proportional hazards models to determine the adjusted likelihood of undergoing revascularization procedures for each of the three smoking status groups, while controlling for other factors that might influence the likelihood of revascularization. These factors were age, sex, co-morbidities (e.g. diabetes, renal disease), previous invasive cardiac procedures, thrombolytic therapy, indication for catheterization (recent myocardial infarction, unstable angina, stable angina, other), left ventricular ejection fraction, and extent of coronary artery disease.

All analyses were conducted by one of the study authors (P.D.F.) using S-Plus, Version 5, for Linux (Insightful Corporation, Seattle, WA, USA, 1999). The APPROACH initiative has been reviewed and approved by the ethics review committees of the University of Calgary, Calgary, Alberta, and the University of Alberta, Edmonton, Alberta.

Results

From January 1995 to December 1997, 20 406 patients underwent cardiac catheterization in Alberta. Their mean age was 62.5 years and 32% were female. Twenty-five percent of these patients were current smokers, 36.6% were former smokers, and the remaining 38% had never smoked. Baseline patient characteristics (Table 1) show that current smokers were younger, more likely to be male and to have had previous myocardial infarction and thrombolytic therapy than never smokers. The distribution of the clinical indication for catheterization showed that smokers were more likely to undergo cardiac catheterization with an indication of 'myocardial infarction' than were non-smokers. Correspondingly, smokers were less likely to have stable angina as the indication for their procedures.

Figure 1 presents time-to-event curves for the endpoints of any revascularization procedure (Figure 1A), percutaneous coronary intervention (Figure 1B), and coronary artery bypass grafting (Figure 1C) in the 12 months after the index cardiac catheterization. The plots suggest that smokers (current or former) are more likely to undergo revascularization procedures than are never smokers ($P < 0.001$ for all three analyses). However, because the demographic and clinical characteristics differed across the three groups, a multivariable proportional hazards analysis was performed. This analysis indicated that smoking status was not an independent predictor of the probability that a patient would undergo revascularization procedures (Table 2). When compared with never smokers (reference group), the hazard ratio for undergoing any revascularization procedure (percutaneous coronary intervention or coronary artery bypass grafting) after catheterization was 0.98 (95% CI 0.93–1.03) for current smokers and 0.98

Table I Patient characteristics

Variable	Smoking category			
	Never	Previous	Current	*P*-value[1]
	N = 7752	*N* = 7472	*N* = 5182	
	(38.0%)	(36.6%)	(25.4%)	
Mean age (years)	64.7	64.3	56.4	<0.001
Sex (% female)	40.1	20.2	26.9	<0.001
Peripheral vascular disease (%)	5.1	8.6	8.8	<0.001
Chronic lung disease (%)	6.9	10.3	11.2	<0.001
Cerebrovascular disease (%)	5.9	6.4	5.2	0.021
Creatinine > 200 mmol/litre (%)	3.0	2.1	1.9	<0.001
Congestive heart failure (%)	14.5	15.0	13.2	0.019
Dialysis (%)	1.6	1.2	1.0	0.019
Diabetes (%)	20.0	18.8	15.9	<0.001
Hypertension (%)	54.6	54.0	46.7	<0.001
Hyperlipidemia (%)	39.3	45.7	46.2	<0.001
Liver disease (%)	2.8	3.6	3.8	0.004
Malignancy (%)	3.2	3.9	2.7	<0.001
Previous myocardial infarction (%)	45.4	50.9	58.1	<0.001
Previous CABG[2] (%)	7.5	10.0	4.4	<0.001
Previous PCI[2] (%)	11.0	13.3	8.8	<0.001
Prior thrombolytic therapy (%)	9.4	10.7	17.3	<0.001
Indication for catheterization (%)				<0.001
Myocardial infarction	23.5	21.9	37.3	
Stable angina	32.0	35.0	25.1	
Unstable angina	30.5	31.3	28.2	
Other	14.0	11.8	9.4	
Extent of coronary disease (%)				<0.001
Normal or near normal	24.3	16.4	17.5	
1–2 vessel disease	20.4	22.6	29.1	
2 vessel disease + PLAD[2]	14.5	15.1	16.7	
3 vessel disease	18.6	20.9	18.7	
3 vessel disease + PLAD[2]	14.1	15.4	11.8	
Left main disease	8.0	9.5	6.3	
Ejection fraction (%)				<0.001
<30	4.3	5.6	5.6	
30–50	19.7	21.9	23.1	
>50	57.6	57.0	55.8	
Ventriculogram not done	4.8	3.8	3.9	
Missing	13.6	11.6	11.6	

[1] *P* value based on analysis of variance for age comparisons, and on chi-squared tests for all other comparisons.
[2] Abbreviations: CABG, coronary artery bypass grafting; PCI, percutaneous coronary intervention; PLAD indicates disease involving the proximal left anterior descending artery.

(0.94–1.03) for former smokers. The hazard ratio for undergoing coronary artery bypass grafting was 1.09 (1.00–1.19) for current smokers and 1.00 (0.93–1.08) for former smokers. For percutaneous coronary intervention, the corresponding hazard ratios were 0.93 (0.87–0.99) for current smokers and 1.00 (0.94–1.06) for former smokers (Table 2).

We also performed selected subgroup analyses to determine whether there were specific patient subgroups in whom smoking status might play a more important role. Specifically, we formally assessed whether age (<65 versus ≥65), sex, congestive heart failure, or diabetes modified our findings, and also tested the statistical significance of two-way interaction terms between these variables and smoking. These supplementary analyses revealed no statistically significant interaction terms, and for the most notable endpoint of any revascularization procedure, none of the smoking hazard

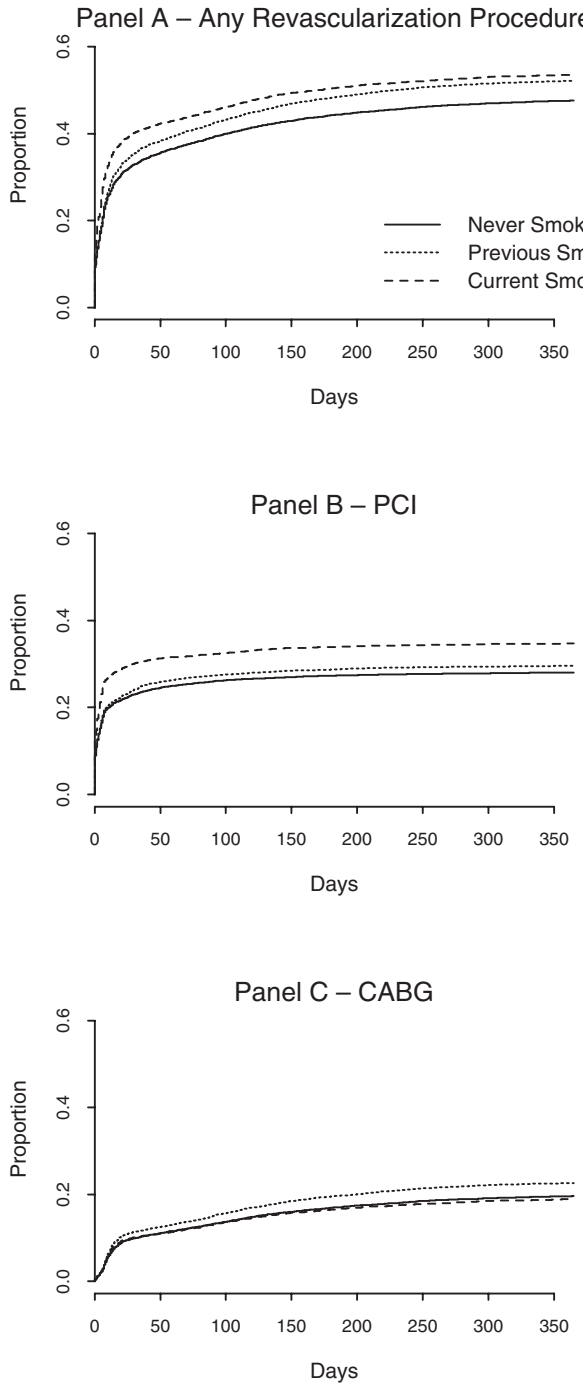

Figure 1 Time-to-event curves by smoking status group for the endpoints of any revascularization procedure (Panel A), percutaneous coronary intervention (PCI; Panel B), and coronary artery bypass grafting (CABG; Panel C) in the 12 months after cardiac catheterization.

ratios differed significantly from 1.0. Hazard ratios for these subgroup analyses (for smokers relative to non-smokers) ranged from a low of 0.93 (0.82–1.07) to a high of 1.03 (0.94–1.13).

Table 2 Adjusted hazard ratios[1] indicating likelihood of revascularization

Type of revascularization	Hazard ratio	95% Confidence intervals
Current smokers versus never smokers		
Any type	0.98	0.93–1.03
CABG[2]	1.09	1.00–1.19
PCI[2]	0.93	0.87–0.99
Former smokers versus never smokers		
Any type	0.98	0.94–1.03
CABG[2]	1.00	0.93–1.08
PCI[2]	1.00	0.94–1.06

[1]Hazard ratios are adjusted for all of the clinical factors listed in Table 1.
[2]Abbreviations: CABG, coronary artery bypass grafting; PCI, percutaneous coronary intervention.

Discussion

By focusing on events after cardiac catheterization, our study assesses the latter portion of the coronary revascularization care sequence. This is a period during which interventional cardiologists and cardiac surgeons are asked to accept patients for revascularization procedures—a decision-making process that smoking status may influence. Despite this possibility, however, our findings indicate that smokers are not less likely than non-smokers to undergo coronary revascularization in the year following cardiac catheterization.

Underwood and Bailey [6] have argued that, in the context of limited resources, offering smokers cardiac surgery 'deprives patients who have never smoked or have stopped smoking of more efficient and effective surgery'. They defend this argument by pointing out that patients who smoke may spend longer in hospital and have poor results from surgery. In concluding their commentary, these authors boldly declare that 'subjecting patients who continue to smoke and for whom the only indication for operation is the relief of angina, to the increased risks of surgery in the face of a remediable cause is not justified'. Of relevance, these comments shortly predated the years we assessed in this study using APPROACH data.

Others argue against this position on both financial and ethical grounds. In particular, Shiu [10] has illustrated the dangers of discriminating against smokers by pointing out that we could similarly deny care to drunken victims of traffic accidents, suicide survivors, asthmatic smokers, and others. Our findings suggest that cardiac care providers in the region studied have not widely adopted the view of Underwood and Bailey.

While equally likely to undergo any revascularization relative to patients who have never smoked, current smokers were somewhat less likely to undergo percutaneous coronary

intervention. This was countered by a slightly greater likelihood of undergoing coronary artery bypass grafting. While this finding raises the possibility of differing attitudes towards smokers among interventional cardiologists compared with cardiac surgeons, the fact that the most important endpoint of any revascularization procedure was equivalent between groups indicates globally similar access to cardiac care regardless of smoking status.

This report has several strengths. Firstly, our database contains relevant clinical information on a wide variety of clinical variables that can affect the likelihood of cardiac procedures, such as extent of coronary disease, left ventricular ejection fraction, co-morbidities, and previous cardiovascular procedures [11]. This database provided the opportunity to study the relationship between smoking status and revascularization procedures while controlling for these other important factors. Secondly, data come from an unselected population within a defined geographic area and from a health care system with a single payer and equal access. This limits the impact of provider factors and health care insurance coverage on the likelihood of undergoing revascularization procedures. Finally, we performed a careful statistical adjustment when comparing the use of cardiac procedures among groups of differing smoking status.

Our study also has some limitations. First, the results are limited to one region and they may not apply to other regions. Second, the possibility of biased clinical decision-making prior to referral for cardiac catheterization cannot be excluded. However, our focus on revascularization decisions after catheterization is nonetheless relevant because, as mentioned earlier, this is a time at which cardiac surgeons and interventional cardiologists are asked to accept a patient for treatment (i.e. a process in which smoking might be held against the patient). Third, our study is a population-based study that assesses data from a number of providers in aggregate to determine whether there is evidence of bias against smokers in clinical decision-making after cardiac catheterization. Using such an approach, we can not exclude the possibility that there could be individual providers (or a small subgroup of providers) who are nonetheless expressing bias against smokers in their clinical decision-making. Our study does not have the statistical power to detect bias in clinical decisions at the level of individual providers. And finally, smoking status was ascertained only at the time of cardiac catheterization for our study. We notably do not have information on potential changes in smoking status in the follow-up period after catheterization, and it is possible that changes in smoking status after catheterization could influence clinical decisions, just as could smoking status at baseline. This issue of changes in smoking status, and the influence of such changes on clinical decisions, deserves further study.

These limitations and caveats aside, our study is nonetheless informative. Despite potential for discrimination on the basis of smoking status in revascularization treatment decisions, current and former smokers undergoing cardiac catheterization in Alberta, Canada are as likely as patients who have never smoked to undergo revascularization procedures. These results do not preclude the possibility of biased clinical decision-making prior to referral for cardiac catheterization or in other geographic regions. They also do not exclude the possibility that changes in smoking status after catheterization could influence clinical decisions.

Acknowledgements

The authors thank Dr Michelle Graham and Dr Ross Tsuyuki (both in the Division of Cardiology, University of Alberta) and Dr L. Brent Mitchell (Division of Cardiology, University of Calgary) for their helpful comments on earlier drafts of this paper.

We also acknowledge the data collection and data entry contributions of the personnel in the cardiac catheterization laboratories at the Foothills Hospital, Calgary; Royal Alexandra Hospital, Edmonton; and the University of Alberta Hospital, Edmonton.

Members of the APPROACH project Clinical Steering Committee: Edmonton—Dr William Hui (chair), Dr Michelle Graham, Dr Stephen Archer, Dr Arvind Koshal, Dr Ross Tsuyuki, and Dr Colleen M. Norris; Calgary—Dr L. Brent Mitchell, Dr Michael Curtis, Dr Merril L. Knudtson, Dr William A. Ghali, Dr Andrew Maitland, and Ms Diane Galbraith.

The APPROACH initiative was initially funded in 1995 by a grant from the Weston Foundation. The ongoing operation of the project has been made possible by contributions from the Province-Wide Services Committee of Alberta Health and Wellness, Merck Frosst Canada Inc., Monsanto Canada Inc.–Searle, Eli Lilly Canada Inc., Guidant Corporation, Boston Scientific Ltd, Hoffmann-La Roche Ltd, and Johnson & Johnson Inc–Cordis. We appreciate the assistance of the Calgary Health Region and the Capital Health Authority in supporting on-line data entry by cardiac catheterization laboratory personnel. Analysis for this project was supported by an operating grant from the Heart and Stroke Foundation of Alberta, North West Territories and Nunavut. We thank Mr Jason Badry, Systems Analyst responsible for software development and for establishing and maintaining data linkages for the Project.

M.L.K. receives partial support from the Libin Trust Fund. W.A.G. is supported by a Government of Canada Research Chair in Health Services Research and by a Health Scholar Award from the Alberta Heritage Foundation for Medical Research, Edmonton, Alberta. P.D.G. is supported by: (i) a Canadian Cardiovascular Outcomes Research Team (www.ccort.ca) student fellowship, funded by an operating grant from the Canadian Institutes of Health Research and the Heart and Stroke Foundation and (ii) a TORCH—Tomorrows Research Cardiovascular Health Professionals (www.torch.ca) student fellowship.

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Accepted for publication 27 September 2004