Chapter 18: Revascularization use and survival outcomes after cardiac catheterization in British Columbia and Alberta

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BACKGROUND: Alberta and British Columbia have comprehensive cardiac databases that provide detailed demographic, clinical and procedural data, including coronary anatomy, on all patients undergoing cardiac catheterization.

OBJECTIVES: To examine the baseline clinical characteristics of patients undergoing cardiac catheterization, describe the use of revascularization treatments (percutaneous coronary intervention [PCI] and coronary artery bypass grafting [CABG]) following catheterization, and describe survival after cardiac catheterization, stratified by treatment strategy received and proposed, using cardiac databases from Alberta and British Columbia.

PATIENTS AND METHODS: All patients between 20 and 105 years of age, admitted to hospital for their first coronary angiography between April 1, 1995, and March 31, 2001, with angiographic evidence of coronary disease were included in the study. Procedure volumes, baseline characteristics and therapy received within one year of cardiac catheterization are described by province. Stepwise, multivariate logistic regression analysis was used to model determinants of the revascularization modality. Kaplan-Meier curves of one-year survival after index cardiac catheterization were estimated for the therapy received (Alberta and British Columbia) and the therapy proposed (British Columbia only).

RESULTS: Patients were predominantly men (70%), commonly presented with two- or three-vessel disease, and frequently had hypertension, a history of myocardial infarction and dyslipidemia. Within one year of catheterization, 21% to 26% underwent CABG and 32% to 42% underwent PCI. Emergency or urgent status at the time of catheterization was associated with receiving PCI, while three-vessel and left main disease were associated with receiving CABG. Patients who did not undergo revascularization within one year (presumed medical therapy) had the lowest one-year survival rate (93.4%; 95% CI 92.1% to 94.7%); this group comprised patients receiving medical therapy as proposed (one-year survival rate of 95.7%, 95% CI 94.6% to 96.8%), as well as patients receiving medical therapy at variance with the proposal for revascularization (84.6%; 95% CI 80.5% to 88.9%).

CONCLUSIONS: Between 53.1% and 67.5% of patients presenting for cardiac catheterization undergo revascularization within one year. Urgent status increased the probability of PCI, and anatomy (ie, three-vessel and left main) increased the probability of CABG. Patients not undergoing proposed revascularization by one year had poorer outcomes, in contrast with those proposed for medical therapy, who had excellent outcomes.

Key Words: *Angiography; Angioplasty; Bypass; Coronary disease; Health outcomes; Revascularization*

Taux de revascularisation et de survie après un cathétérisme cardiaque en Colombie-Britannique et en Alberta

CONTEXTE : L'Alberta et la Colombie-Britannique (C.-B.) sont dotées de bases de données globales sur les maladies cardiovasculaires, qui fournissent des renseignements détaillés d'ordre démographique, clinique et chirurgical ou interventionnel, y compris de nature anatomo-coronarienne, sur tous les patients ayant subi un cathétérisme cardiaque.

BUTS : Relever les caractéristiques cliniques de départ des patients ayant subi un cathétérisme cardiaque; examiner le recours aux traitements de revascularisation (intervention coronarienne percutanée [ICP] ou pontage coronarien) après le cathétérisme; dégager les taux de survie après le cathétérisme, suivant les stratégies de traitement appliqué ou proposé, à partir des bases de données des deux provinces.

PATIENTS ET MÉTHODE : Tous les patients âgés entre 20 et 105 ans, hospitalisés pour une première coronarographie entre le 1er avril 1995 et le 31 mars 2001 et présentant des signes angiographiques de coronaropathie ont été retenus dans l'étude. Nous avons d'abord recueilli, dans chacune des provinces, des données sur les volumes d'intervention, les caractéristiques de départ et le traitement appliqué au cours de l'année ayant suivi le cathétérisme. Nous avons ensuite modélisé les déterminants des formes de revascularisation à partir des résultats de l'analyse séquentielle, multifactorielle, de régression logistique. Nous avons enfin appliqué la méthode de Kaplan-Meier pour estimer les courbes de survie au bout d'un an après le cathétérisme cardiaque de référence en fonction du traitement appliqué (Alberta et C.-B.) et du traitement proposé (C.-B. seulement).

RÉSULTATS : La plupart des patients (70 %) étaient des hommes; ils présentaient souvent une atteinte bi- ou tritronculaire, de l'hypertension, des antécédents d'infarctus du myocarde et de la dyslipidémie. Au cours

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de l'année suivant le cathétérisme, de 21 à 26 % des patients avaient subi un pontage et de 32 à 42 %, une ICP. Les ICP étaient associées aux soins d'urgence au moment du cathétérisme et les pontages, aux atteintes tritronculaires et aux lésions du tronc coronaire gauche. Les patients qui n'avaient pas subi de traitement de revascularisation au cours de l'année suivant le cathétérisme (traitement médical supposé) connaissaient le taux de survie le plus faible au bout d'un an (93,4 %; intervalle de confiance [IC] à 95 % : 92,1 % – 94,7 %). Ce groupe se composait de patients soumis au traitement médical proposé (95,7 % : taux de survie au bout d'un an; IC à 95 % : 94,6 % – 96,8 %) et de patients suivant un traitement médical de rechange au traitement de revascularisation proposé mais non désiré (84,6 %; IC à 95 % : 80,5 % – 88,9 %).

CONCLUSIONS : Entre 53,1 et 67,5 % des patients soumis à un cathétérisme cardiaque ont subi un traitement de revascularisation au cours de l'année qui a suivi. Les soins d'urgence étaient davantage associés aux ICP et les facteurs anatomiques (atteinte tritronculaire ou lésions du tronc coronaire gauche), au pontage. Les patients qui n'avaient pas subi le traitement de revascularisation proposé au bout d'un an connaissaient l'issue la plus défavorable, contrairement aux patients soumis au traitement médical proposé, qui connaissaient une issue très favorable.

Cardiovascular disease accounts for a high proportion of deaths, morbidity and health care costs in Canada. Cardiac catheterization is an important diagnostic test to detect the presence and severity of coronary artery disease. Because cardiac catheterization is a necessary precursor to percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG), its availability limits access to these revascularization procedures. Understanding the subsequent fate of those who have had cardiac catheterization provides important insight into the decision-making processes used by those providing cardiovascular care.

Alberta and British Columbia have comprehensive cardiac catheterization databases that provide detailed demographic, clinical and procedural data, including coronary anatomy, on all patients undergoing cardiac catheterization. A key strength of these databases is the complete capture of a geographically defined population of patients. This reduces selection bias, inherent in institution-specific analyses, and facilitates comprehensive follow-up. These databases provide a unique opportunity to describe the clinical events that occur after cardiac catheterization and the baseline clinical characteristics that are associated with the occurrence of events. Our specific objectives in the present study were to describe the baseline clinical characteristics of patients undergoing cardiac catheterization in Alberta and British Columbia; to describe the use of revascularization treatments (PCI and CABG) after catheterization; and to describe survival outcomes after cardiac catheterization, stratified by the initially proposed treatment strategy (PCI versus CABG versus medical therapy).

PATIENTS AND METHODS

Patients

All patients admitted to hospital for diagnostic cardiac catheterization between April 1, 1995, and March 31, 2001, in Alberta and between July 1, 1999, and March 31, 2001, in British Columbia were eligible for the study cohort. All analyses are based on the first, or index, catheterization only. Therefore, for a patient who underwent more than one catheterization during this period, only the first event was considered. Similarly, patients with a known history of previous PCI or CABG were excluded. Those undergoing both a cardiac catheterization and PCI during the same session (an ad hoc procedure) were counted as undergoing a catheterization and PCI. Patients younger than 20 years of age, older than 105 years of age or with normal coronaries (ie, no visible lesions) by angiography were also excluded.

Data sources

Data on patients undergoing cardiac catheterization in Alberta were obtained from the Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH). Data on British Columbia patients were obtained from the British Columbia Cardiac Registries. The two provincial cardiac registry initiatives are collaborating entities, and efforts have been made to standardize data definitions in the two registries so that data-sharing initiatives, such as the present analysis, can proceed seamlessly.

Variables

Urgency status is captured in the registries at the time of cardiac catheterization, and coded as "emergency" (priority case – proceed without delay; laboratory opened after hours, if necessary), "urgent" (patient requires procedure as soon as possible before hospital discharge), "semi-urgent" (high priority outpatient, maximum wait target of one month) or "elective" (next available outpatient slot). Comorbidities were determined based on data recorded in the registries and/or on *International Classification of Diseases, 9th revision (Clinical Modification)* (1) coding of comorbidity in the hospitalization record at the time of the index visit (2). Comorbidity was deemed present if recorded either in the registries or in the hospital record. Coronary anatomy is recorded in the respective registries at the time of index catheterization, and a vessel is considered to be diseased when it has a lesion causing at least 50% luminal diameter reduction.

The registries also capture ejection fraction at the time of diagnostic catheterization and the initial treatment proposed by the angiographer. The initial treatment proposed by the angiographer at the time of cardiac catheterization was used to evaluate outcomes on the basis of 'proposed therapy'. In addition to diagnostic cardiac catheterization data, both registries prospectively capture revascularization procedures – PCIs and CABGs – performed in the respective provinces.

Analyses

Use of revascularization procedures following cardiac catheterization is reported as proportions of patients undergoing PCI, CABG (with or without valve procedures) or medical therapy within one year of cardiac catheterization. Thus, if revascularization occurred more than one year after cardiac catheterization, the patient was deemed to have received medical therapy. Stepwise, multivariate logistic regression analysis was used to model determinants of the revascularization modality. Urgency status, anatomy and comorbidities were first examined in univariate analyses. Those variables significantly associated with the revascularization modality ($P<0.1$) were entered stepwise into a multivariate model. Determinants of the revascularization modality (PCI versus CABG) were first modelled separately for each province. Because of the consistent findings, the data sets were combined for the period between July 1, 1999, and March 31, 2000, and only the combined analysis is presented. Kaplan-Meier curves of unadjusted survival after the index cardiac catheterization are presented by therapy received for both provinces. For British Columbia only, Kaplan-Meier curves of one-year survival by therapy initially proposed are also presented.

TABLE 1
Overall* and index† cardiac catheterization procedures by year and province

	Alberta				British Columbia			
			Rate per 100,000				Rate per 100,000	
Year	Overall	Index	Overall	Index	Overall	Index	Overall	Index
1995/1996	7295	4052	385.3	214.0	N/A	N/A	N/A	N/A
1996/1997	7534	4131	393.0	215.5	N/A	N/A	N/A	N/A
1997/1998	7938	4178	406.5	214.0	N/A	N/A	N/A	N/A
1998/1999	8591	4291	428.6	214.1	N/A	N/A	N/A	N/A
1999/2000	9835	5137	477.8	249.6	9392	5188‡	N/A	N/A
2000/2001	10,470	5807	498.7	276.6	15,144	7695	499.6	253.9

*Counts reflect the total number of cardiac catheterization procedures performed in each fiscal year; †Index cases exclude patients with prior cardiac catheterization, percutaneous coronary intervention or coronary artery bypass grafting, and patients without angiographic evidence of coronary disease; ‡Nine months of data only, beginning July 1, 1999. N/A Data not available

TABLE 2
Baseline characteristics at the time of index cardiac catheterization

	Alberta (n=27,596)	British Columbia (n=12,883)
Women (%)	28.6	28.6
Emergency (%)	7.3	5.2
Urgent/semi-urgent (%)	63.1	53.9
Elective (%)	29.6	40.8
Age (%)		
20 to 49 years	14.3	9.9
50 to 64 years	38.1	36.0
65 to 74 years	31.2	32.8
75+ years	16.4	21.4
Diseased vessels (%)		
<50% or one vessel	40.0	35.8
Two vessels	24.0	23.9
Three vessels	28.0	32.0
Left main	8.0	8.3
Renal dysfunction (%)*	2.7	2.5
Congestive heart failure (%)	14.7	12.2
Prior myocardial infarction (%)	48.9	38.4
Hypertension (%)	53.0	53.0
Diabetes mellitus (%)	20.0	23.1
Dyslipidemia (%)	47.3	55.6
Peripheral vascular disease (%)	7.9	9.4
Prior stroke (%)	6.5	8.6
Ejection fraction (%)		
<30%	4.7	4.0
30% to 50%	20.5	21.3

*Elevated creatinine or on dialysis

TABLE 3
Therapy received within one year of cardiac catheterization

	Alberta			British Columbia		
	CABG (%)	PCI (%)	Medical Tx (%)	CABG (%)	PCI (%)	Medical Tx (%)
1995/1996	24.2	32.2	43.6	N/A	N/A	N/A
1996/1997	23.7	34.9	41.4	N/A	N/A	N/A
1997/1998	23.4	36.3	40.4	N/A	N/A	N/A
1998/1999	24.4	38.0	37.5	N/A	N/A	N/A
1999/2000	22.9	37.6	39.6	25.8	41.2	33.1
2000/2001	20.9	38.8	40.3	24.3	41.7	34.1

CABG Coronary artery bypass grafting; N/A Data not available; PCI Percutaneous coronary intervention; Tx Therapy

RESULTS

Index cardiac catheterization by year and province

The study cohort comprised all patients with angiographic evidence of coronary disease undergoing their first (index) cardiac catheterization in Alberta and British Columbia. In Alberta, from 1995/1996 to 1998/1999, the number of index procedures was fairly stable but increased substantially in 1999/2000 and again in 2000/2001 (Table 1). In Alberta, of 37,875 index catheterizations, 4808 (12.7%) were excluded because they were normal and 5471 (14.4%) were excluded because the patients had a previous PCI or CABG, leaving 27,596 in the analysis. In British Columbia, of 20,840 index catheterizations, 4231 (20.3%) were excluded because they were normal, 3722 (17.9%) were excluded because the patients had a previous PCI or CABG, and four were excluded because of age, leaving 12,883 in the analysis.

Baseline characteristics of patients presenting for cardiac catheterization

Baseline characteristics of patients from British Columbia and Alberta with angiographic evidence of coronary disease at the time of their index catheterization are presented in Table 2. In both provinces, more than one-half of the procedures were semi-urgent or urgent, less than 30% of the patients were women, more than two-thirds of patients were between the ages of 50 and 74 years, the majority of the patients had two- or three-vessel or left main disease, and one-quarter had ejection fractions less than 50%. The most common comorbidities were hypertension, prior myocardial infarction and dyslipidemia.

Therapy received within one year of index catheterization

Table 3 illustrates the distribution of therapies received within one year of the index catheterization. It is important to note that if a patient underwent PCI and then CABG, they appear as PCI for this analysis. If they underwent neither a PCI nor a CABG within one year of cardiac catheterization, then they were considered to have received medical therapy. In both provinces, the lowest proportion of patients (21% to 26%) received CABG. In Alberta, the remaining patients were almost equally distributed between PCI and medical therapy, except between 1995/1996 and 1997/1998. In British Columbia, patients were most likely

TABLE 4
Therapy received within one year of cardiac catheterization by age and sex

		Alberta			British Columbia		
Sex	Age (years)	CABG (%)	PCI (%)	Medical Tx (%)	CABG (%)	PCI (%)	Medical Tx (%)
Men	20–49 (n=3241)	13.3	50.0	36.8	14.1	59.2	26.7
	50–64 (n=8044)	24.0	41.1	34.9	23.6	46.7	29.8
	65–74 (n=5812)	31.5	31.3	37.2	33.8	34.5	31.7
	75+ (n=2611)	30.8	27.8	41.5	32.3	33.3	34.4
Women	20–49 (n=710)	10.6	41.8	47.6	12.0	50.0	38.0
	50–64 (n=2476)	14.4	34.6	51.0	17.9	41.2	40.8
	65–74 (n=2790)	21.7	32.0	46.2	20.7	40.0	39.3
	75+ (n=1912)	17.9	29.4	52.7	18.9	38.2	43.0

CABG Coronary artery bypass grafting; PCI Percutaneous coronary intervention; Tx Therapy

TABLE 5
Baseline characteristics by therapy received within one year of cardiac catheterization

	Alberta			British Columbia		
	CABG (%)	PCI (%)	Medical Tx (%)	CABG (%)	PCI (%)	Medical Tx (%)
Emergency	10.9	71.8	17.4	11.7	76.7	11.7
Urgent/semi-urgent	24.1	38.7	37.2	23.8	48.1	28.1
Elective	23.7	27.1	49.2	27.9	28.3	43.8
Diseased vessels						
<50% or one vessel	3.6	39.4	57.0	4.9	46.9	48.2
Two vessels	15.2	52.4	32.4	16.2	58.5	25.3
Three vessels	42.3	27.8	29.9	42.8	30.2	27.0
Left main	77.0	4.8	18.2	66.7	12.3	20.9
Renal dysfunction	25.9	24.8	49.3	24.0	28.1	48.0
Congestive heart failure	25.6	25.0	49.4	30.1	24.5	45.4
Prior myocardial infarction	23.7	41.7	34.9	24.7	47.9	27.4
Hypertension	25.7	33.4	40.9	26.2	38.9	35.0
Dyslipidemia	25.8	38.5	35.7	26.7	41.1	32.3
Diabetes mellitus	27.5	31.4	41.1	28.2	37.0	34.9
Peripheral vascular disease	31.4	23.3	45.4	28.8	32.5	38.7
Prior stroke	30.3	25.6	44.1	30.8	30.2	39.0
Ejection fraction						
<30%	22.8	21.1	56.2	30.2	24.1	45.7
30% to 50%	28.9	34.4	35.8	28.2	40.3	31.5
>50%	21.1	37.6	41.3	24.4	40.1	35.5
Other comorbidities*	23.9	30.9	45.2	23.3	36.1	40.6

**Pulmonary, liver, gastrointestinal or malignancy. CABG Coronary artery bypass grafting; PCI Percutaneous coronary intervention; Tx Therapy*

to undergo PCI after cardiac catheterization. A slightly higher proportion of patients in British Columbia compared with in Alberta were revascularized.

Therapy received by age and sex

As shown in Table 4, women of all ages were less likely to undergo CABG than were men in both British Columbia and Alberta. All patients younger than 65 years of age were more likely to receive PCI than CABG. Men younger than 65 years of age were more likely to undergo PCI than were women of the same age. However, among those 65 years and older, women were more likely to undergo PCI than men. In general, women were more likely to receive medical therapy than revascularization. The proportion of patients undergoing PCI declined with increasing age, while the proportion undergoing CABG increased up to 65 to 74 years of age and then declined in those older than 75 years. At all ages and for both men and women, medical therapy was more common in Alberta than in British Columbia.

Baseline characteristics and therapy received

The effects of urgency, anatomy and comorbidities on therapy received in each province are illustrated in Table 5. Three-quarters of patients with emergency status at the time of cardiac catheterization were revascularized by PCI, while elective patients were most likely to receive medical therapy. Patients with left main disease were most likely to undergo CABG. For those with diabetes mellitus, medical therapy (Alberta) and PCI (British Columbia) were used more often than CABG. Prior stroke, peripheral vascular disease, renal dysfunction, congestive heart failure and an ejection fraction less than 30% were associated with receiving medical therapy.

TABLE 6
Multivariate determinants of revascularization modality received

Characteristic	n	OR	95% CI	
Emergency*	634	6.30	4.74–8.37	↑
Urgent*	5287	2.12	1.88–2.38	Favours
Prior MI	4918	1.38	1.23–1.54	PCI
50 to 64 years†	3756	0.68	0.56–0.82	Favours
65 to 74 years†	3069	0.48	0.40–0.58	CABG
75+ years†	1828	0.66	0.54–0.82	
Hypertension	5248	0.88	0.79–0.98	
PVD	806	0.80	0.67–0.97	
Men	7434	0.74	0.66–0.84	
EF (30% to 50%)‡	2680	0.82	0.73–0.93	↓
EF (<30%)‡	364	0.76	0.58–1.01	
Prior stroke	712	0.70	0.57–0.85	
CHF	1037	0.51	0.43–0.61	
Two vessels§	2619	0.33	0.28–0.39	
Three vessels§	3380	0.06	0.05–0.07	
Left main§	979	0.01	0.00–0.01	

**Compared with elective (n=3124); †Compared with patients aged 20 to 49 years (n=1238); ‡Compared with ejection fraction (EF) greater than 50% (n=6747); §Compared with one-vessel disease or less than 50% disease (n=2813). CABG Coronary artery bypass grafting; CHF Congestive heart failure; MI Myocardial infarction; PCI Percutaneous coronary intervention; PVD Peripheral vascular disease*

Determinants of revascularization modality within one year of cardiac catheterization

Table 6 presents the results of a multivariate analysis predicting the type of revascularization in an analysis confined to patients who were revascularized (ie, medically treated patients were excluded from the analysis). Data from both provinces were combined for the analysis (n=9790; time frame July 1, 1999, to March 31, 2000). Urgency status and prior myocardial infarction were associated with PCI. Increasing age, male sex, reduced ejection fraction, history of stroke or congestive heart failure, left main disease and multivessel disease were associated with CABG. Hypertension and peripheral vascular disease were weakly associated with CABG in Alberta.

One-year survival after index cardiac catheterization

Kaplan-Meier curves of survival one year after cardiac catheterization are presented in Figures 1A (Alberta) and 1B (British Columbia). The curves present survival based on the therapy received. Patients who did not undergo PCI or CABG within one year were classified as medical therapy, although it is important to appreciate that patients undergoing revascularization would get medical therapy as well. As illustrated, patients who did not undergo PCI or CABG within one year had the lowest survival rates (93.4%; 95% CI 92.1% to 94.7%) and patients who received PCI had the best survival rates (96.8%; 95% CI 96.0% to 97.7%).

Therapy received compared with therapy recommended (British Columbia data only)

To understand the difference between medical therapy prospectively assigned and medical therapy defined as the absence of revascularization, the proportion of patients who received the therapy first proposed by the angiographer at the time of index catheterization was determined. As shown in Table 7, patients referred for PCI were the most likely to undergo the proposed therapy (93.2%). Only 12.7% of those for whom the initial proposal was for medical therapy underwent revascularization in the next year. In contrast, 27.7% of patients for whom CABG was first proposed did not undergo CABG; 5.2% underwent PCI instead and the remainder (22.5%) received medical therapy.

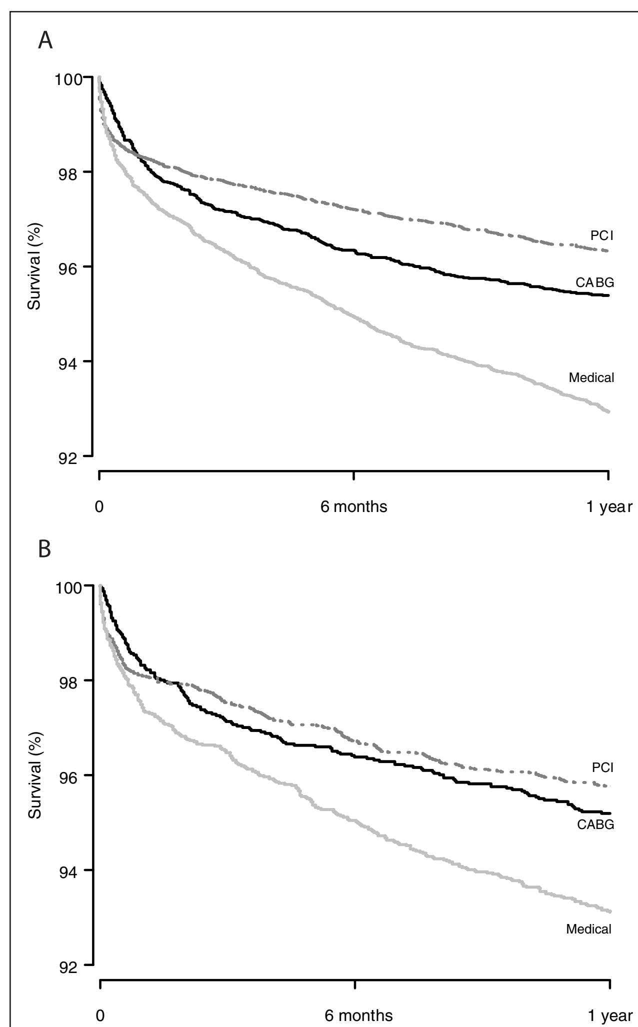

Figure 1) *One-year survival following cardiac catheterization for patients in Alberta (**A**) and British Columbia (**B**). CABG Coronary artery bypass grafting; Medical Medical therapy; PCI Percutaneous coronary intervention*

TABLE 7
Therapy received compared with therapy proposed at time of catheterization (British Columbia only)

	Therapy received		
	CABG	PCI	Medical Tx
Therapy proposed			
CABG	2735 (72.3%)	197 (5.2%)	853 (22.5%)
PCI	166 (3.3%)	4745 (93.2%)	178 (3.5%)
Medical Tx	185 (5.3%)	254 (7.3%)	3026 (87.3%)

CABG Coronary artery bypass graft; PCI Percutaneous coronary intervention; Tx Therapy

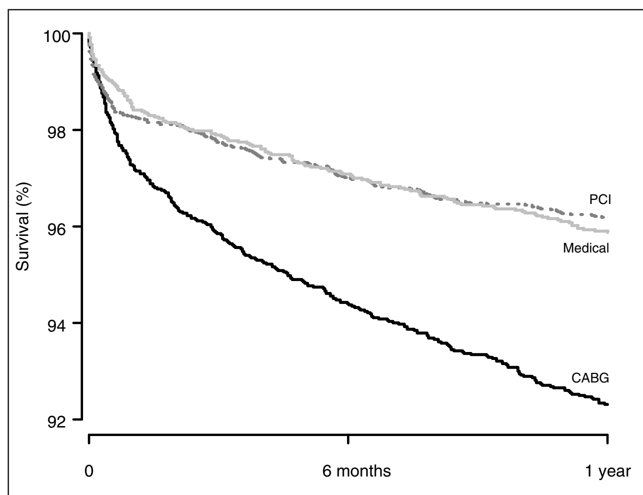

Figure 2) *One-year survival following cardiac catheterization for patients in British Columbia according to the angiographer's initially proposed treatment. Patients proposed for coronary artery bypass grafting (CABG) had the lowest rate of survival. Medical Medical therapy; PCI Percutaneous coronary intervention*

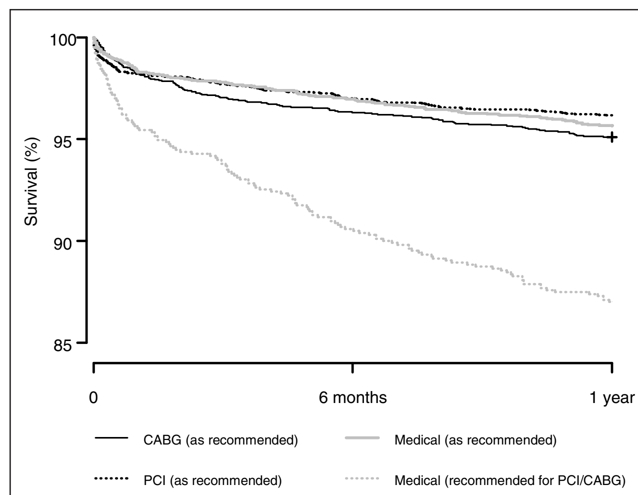

Figure 3) *One-year survival following cardiac catheterization for patients in British Columbia according to the angiographer's initially proposed treatment and the treatment received. Patients who received medical therapy (Medical) when percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG) was proposed had the lowest rate of survival*

To understand the impact of concordance with proposed therapy on survival, we plotted survival based on therapy proposed (Figure 2) for British Columbia patients. PCI (97.1%; 95% CI 96.3% to 97.9%) and medical therapy (95.7%; 95% CI 94.6% to 96.8%) had the highest one-year survival rate, while patients proposed for CABG had the lowest survival rate. To further evaluate those who were proposed for CABG or PCI but did not undergo revascularization, the survival rate of patients where therapy received and proposed were concordant, and of patients where proposed therapy (revascularization) and therapy received (medical therapy) were discordant, were plotted. As illustrated in Figure 3, the discordant group had the lowest survival rates (84.6%; 95% CI 80.5% to 88.9%). There was very little difference in survival between medical therapy, PCI and CABG when therapy proposed and received were concordant.

DISCUSSION

In a cohort comprising patients presenting for their first cardiac catheterization with angiographic evidence of coronary disease, between 53% and 68% undergo revascularization within one year. The rate of catheterizations in Alberta increased from 385.3 per 100,000 population in 1995/1996 to 498.7 per 100,000 in 2000/2001. In British Columbia, the rate of cardiac catheterization in 2000/2001 was 499.6 per 100,000 population.

Urgent status increased the probability of undergoing PCI, and anatomy (ie, three vessel and left main) increased the probability of CABG. Patients who did not undergo revascularization within one year had the lowest one-year survival rate (93.4%). This group comprised patients receiving medical therapy as proposed at the time of cardiac catheterization (one-year survival rate of 95.7%), as well as patients receiving medical therapy at variance with the proposal for revascularization at the time of cardiac catheterization (one-year survival rate of 84.6%).

The baseline characteristics of the population undergoing index coronary angiography appear to drive the process of treatment selection. More than 70% of those having emergency procedures undergo PCI, probably reflecting several attractive features of PCI for those who are unstable: immediate availability, low morbidity, a high rate of immediate procedural success and an effective reperfusion strategy for those with acute myocardial infarction. The rate for PCI (approximately 40%) remains higher than that for CABG among patients in the urgent or semi-urgent category, and only in the elective category are patients roughly equally allocated to PCI or CABG. The increasing use of PCI over time is consistent with the analysis of national revascularization rates presented by Faris et al (3). One must question whether the perceived faster access to PCI than CABG is driving the process of therapy selection or whether cardiologists and patients would choose PCI even if CABG were available with exactly the same waiting time. The high rate of PCI use may also reflect acceptance of a strategy of PCI of presumed culprit lesions accompanied by aggressive secondary prevention therapy as a suitable alternative to attempting to achieve complete revascularization.

More than one-half of the patients with two-vessel disease undergo PCI, while less than one-third of those with three-vessel disease receive PCI, possibly reflecting the increasing risk of restenosis with increasing numbers of vessels treated, a presumed desire to achieve complete revascularization, and the substantial increases in costs that accrue as the number of catheters and stents used increases. PCI was used in approximately one-third of those with diabetes mellitus. Thus, the publication of the Bypass Angioplasty Revascularization Investigation (BARI) results (4) showing an unfavourable outcome of PCI compared with CABG in the subgroup with diabetes has not resulted in abandonment of PCI in this high-risk population. The lower restenosis rates with drug-eluting stents could result in a shift toward PCI if concerns about restenosis prompt the selection of CABG.

The therapy received by age and sex is interesting and reflects the complex decision-making required following coronary angiography. It is apparent that a substantially lower proportion of women than men receive CABG procedures following coronary angiography. Although this has previously

been attributed to a sex bias in the selection of therapy, recent analysis of data from APROACH (5) has shown that the differences were almost entirely accounted for by differences in the extent of coronary artery disease and that the apparent sex bias disappeared once these important clinical differences were accounted for. Although the proportion of women receiving CABG is low and approximately equal in Alberta and British Columbia, the proportion of women at every age who undergo PCI is higher (by approximately 5%) in British Columbia than in Alberta. It is interesting to observe that revascularization rates in those age 75 years and older are similar to those for younger patients, although slightly lower. The overall rate of major adverse cardiac events in the very elderly undergoing PCI is high (6) but better with an invasive approach than with a conservative approach, as recently confirmed in the trial of invasive versus medical therapy in elderly patients with chronic symptomatic coronary artery disease (the TIME trial [7]). APPROACH recently reported that survival in the elderly following revascularization is very good (8). The challenges of delivering cardiovascular care to the elderly have been reviewed (9).

It is impossible to completely rationalize the determinants of therapy received versus therapy proposed by the angiographer at the time of coronary angiography. It is important to note that the angiographer's proposal is a preliminary one made at the time of the procedure, which is heavily influenced by the anatomy and commonly made before discussion with the patient and review by a cardiac surgeon. Additionally, the angiographer may not be completely familiar with the patient or the factors determining the patient's preferences (10,11). For example, the angiographer may not be aware that the patient is determined not to have CABG and may recommend it based on anatomy and left ventricular function. The angiographer may also not be aware of multiple mild or moderate comorbidities not particularly relevant to the angiogram but which, in total, significantly increase the risk for CABG. The attending cardiologist or cardiac surgeon to whom the patient is referred may have different perceptions of risk and benefit from those used by the angiographer in making the initial proposal (12). Because many factors are at play, it is not surprising that a substantial proportion of those patients for whom the angiographer's initial proposal was for CABG in fact received PCI or medical therapy. Nonetheless, the prognosis of those who did not receive CABG as proposed was poorer than those who did. This finding is consonant with those of Hemingway et al (13), who studied the outcomes of patients whose clinical situations were deemed appropriate, inappropriate or uncertain for CABG. For those who received medical therapy but were deemed appropriate for CABG, the hazard ratio for death was 4.96 (95% CI 3.27 to 7.51); for those deemed uncertain for CABG, the hazard ratio was 1.66 (95% CI 0.95 to 2.86), and for those deemed inappropriate for CABG, it was 0.65 (95% CI 0.18 to 2.28) (13).

In the present study, patients for whom CABG was proposed but who received medical therapy had a poor prognosis. However, those who received medical therapy as proposed by the angiographer had a very good prognosis. It seems that currently there is an impetus to revascularize once angiography has been performed. However, the finding of an excellent prognosis for those proposed and receiving medical therapy should comfort those who choose to propose medical therapy when the anatomy is not threatening.

CONCLUSIONS

The pattern of revascularization use following coronary angiography in British Columbia and Alberta is consistent with national trends (3). Choice of revascularization modality is driven by urgency status, with increasing urgency favouring PCI, and anatomy, with three-vessel disease favouring CABG. Survival with each modality is excellent, particularly when the therapy is concordant with the angiographer's initial preliminary proposal. While the results apply most directly to Alberta and British Columbia, the general insights gained from these analyses undoubtedly apply to other provinces as well.

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