Trends in postacute myocardial infarction management and mortality in patients with diabetes. A population-based study from 1995 to 2001

Najwa Ouhoummane PhD[1], Belkacem Abdous PhD[2], Rabia Louchini MSc[1],
Louis Rochette MSc[1], Paul Poirier MD PhD FRCPC FACC FAHA[3]

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OBJECTIVE: To compare trends in coronary revascularization use and case fatality rate (CFR) following acute myocardial infarction in patients with and without diabetes.

METHODS: A retrospective study of 77,552 patients, 20 years of age or older (25% with diabetes), who were hospitalized for a first acute myocardial infarction in the province of Quebec between April 1995 and December 2001 was conducted. Administrative databases were used to identify patients and assess outcomes.

RESULTS: Compared with patients without diabetes, patients with diabetes underwent more coronary artery bypass graft (CABG) surgeries (11.1% versus 8.3%; P<0.0001) but fewer percutaneous coronary interventions (17.1% versus 20.2%; P<0.0001). The use of percutaneous coronary intervention increased substantially over time in both populations, driven mainly by an increase during the index admission (20.6% versus 16.6% per year; P=0.1144 in patients with and without diabetes, respectively). The use of CABG during the index admission increased markedly among patients with diabetes compared with those without (10.3% versus 5.3% per year; P=0.0072); however, at one-year following discharge, CABG use remained stable in patients with diabetes and fell in those without (–0.7% versus –5.3% per year; P=0.2046). Concomitantly, patients with diabetes presented a similar decline in CFR compared with patients without diabetes. The decline was more pronounced during the index admission (–5.0% versus –4.1% per year; P=0.282) than at one-year following discharge (–2.5% versus –2.5% per year; P=0.629) in patients with and without diabetes, respectively. However, fatal outcome remained higher in patients with diabetes than without, with an adjusted RR of 1.21 (95% CI 1.18 to 1.24) at one-year follow-up.

CONCLUSION: Overall, coronary revascularization use and CFR improved over time in patients with diabetes. Nevertheless, the mortality rate in patients with diabetes remains higher than in patients without diabetes, indicating that additional progress is required to improve the poorer prognosis in this population.

Key Words: *Acute myocardial infarction; Diabetes mellitus; Mortality; Revascularization*

Les tendances de prise en charge et de mortalité après un infarctus du myocarde chez les personnes atteintes de diabète : Une étude en population de 1995 à 2001

OBJECTIF : Comparer les tendances de revascularisation coronarienne et le taux de létalité (TDL) après un infarctus aigu du myocarde chez les personnes atteintes et non atteintes de diabète.

MÉTHODOLOGIE : Les chercheurs ont mené une étude rétrospective auprès de 77 552 patients de 20 ans ou plus (25 % atteints de diabète) qui ont été hospitalisés pour un premier infarctus aigu du myocarde dans la province de Québec entre avril 1995 et décembre 2001. Ils ont utilisé les bases de données administratives pour dépister les patients et évaluer les issues.

RÉSULTATS : Par rapport aux autres patients, les patients atteints de diabète ont subi davantage de pontages aortocoronariens (PAC) (11,1 % par rapport à 8,3 %; P<0,0001), mais moins d'interventions coronaires percutanées (17,1 % par rapport à 20,2 %; P<0,0001). Le recours à l'intervention coronaire percutanée a augmenté considérablement au fil du temps au sein des deux populations, surtout à cause d'une augmentation pendant la période d'admission de référence (20,6 % par rapport à 16,6 % par année; P=0,1144 chez les patients atteints de diabète et chez les autres, respectivement). Le recours au PAC pendant la période d'admission de référence a augmenté de manière marquée chez les patients atteints de diabète par rapport aux autres (10,3 % par rapport à 5,3 % par année; P=0,0072), mais un an après le congé, le recours au PAC demeurait stable chez les patients atteints de diabète et diminuait chez les autres (–0,7 % par rapport à –5,3 % par année; P=0,2046). Parallèlement, les patients atteints de diabète ont présenté une diminution similaire du TDL par rapport aux autres patients. Cette diminution était plus prononcée pendant la période d'admission de référence (–5,0 % par rapport à –4,1 % par année; P=0,282) qu'un an après le congé (–2,5 % par rapport à –2,5 % par année; P=0,629) chez les patients atteints de diabète et chez les autres, respectivement. Cependant, le taux de décès demeurait plus élevé chez les patients atteints de diabète que chez les autres, le rapport de risque rajusté s'élevant à 1,21 (95 % IC 1,18 à 1,24) au suivi d'un an.

CONCLUSION : Dans l'ensemble, le recours à la revascularisation coronaire et le TDL ont diminué au fil du temps chez les personnes atteintes de diabète. Néanmoins, le taux de décès chez les patients atteints de diabète demeurait plus élevé que chez les autres patients, ce qui indique qu'il faudra poursuivre les progrès pour améliorer le pronostic plus sombre au sein de cette population.

Diabetes mellitus is a major health problem. In the year 2000 in the province of Quebec, estimates put the prevalence of diabetes among adults 20 years of age or older at 5.1% (1). However, this prevalence is increasing due to the rise in obesity (2) and an aging population (3). Diabetes is associated with a high risk of death due to coronary artery disease (CAD) (4). In the meantime, there have been marked declines in CAD mortality noted over the past 50 years in the general population (5-8). These changes may be attributable to advances in the management of both CAD (5,6,9) and cardiovascular risk factors (9,10). This decline, however, has been less pronounced in patients with diabetes (11,12) – a previously neglected group who were less likely than patients without diabetes to receive therapeutic

[1]*National Public Health Institute of Quebec;* [2]*Population Health Research Unit, Laval University;* [3]*Faculty of Pharmacy, Quebec Heart and Lung Institute, Laval University, Québec, Québec*

Correspondence: Dr Paul Poirier, Faculty of Pharmacy, Quebec Heart and Lung Institute, Laval Hospital, 2725 Chemin Sainte-Foy, Québec, Québec G1V 4G5. Telephone 418-656-4767, fax 418-656-4581, e-mail paul.poirier@criucpq.ulaval.ca

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interventions such as thrombolysis, beta-blockers and revascularization procedures (13,14). In contrast, recent studies (15-18) reported a favourable decline in postacute myocardial infarction (post-AMI) mortality in patients with diabetes and suggest that these improvements are a recent phenomenon (15).

During the past decade, the increasing prevalence of diabetes in the general population and, more particularly, in CAD patients, has received more attention and might have led to changes in health care practices among this population. Coronary revascularization procedures (ie, coronary artery bypass graft [CABG] surgeries and percutaneous coronary interventions [PCIs]) conferred a protective effect against mortality in CAD patients (9). The effectiveness of these interventional treatments in patients with diabetes has been reported in several clinical trials (19-21). This evidence should, in theory, initiate more aggressive use of revascularization procedures in this high-risk population and, thus, may contribute to improved prognosis in these patients. However, the extent of these changes is unknown. The purpose of the present study was to compare the current trends in the use of coronary revascularization procedures and the case fatality rate (CFR) following AMI between patients with and without diabetes.

METHODS

Study population

The Quebec hospital discharge database (Med-Echo; Logibec Group Informatique Ltd, Canada) was used to identify all patients 20 years of age or older who were admitted to any hospital in the province of Quebec between fiscal years 1995 (April 1, 1995, to March 31, 1996) and 2001 (April 1, 2001, to December 31, 2001) with a principal diagnosis of AMI (code 410 in the *International Classification of Diseases, Ninth revision* [ICD-9]). Patients with a previous AMI in the four years before the index admission were excluded to increase the likelihood of identifying the incident case. The validity of the diagnosis coding had been evaluated previously, with a positive predictive value of 96% (22). As in previous studies (8,23,24), several exclusion criteria were applied to ensure the accuracy of the AMI diagnosis. Thus, the following exclusion criteria were used: patients who were not admitted to an acute care facility; patients who were AMI coded as an in-hospital complication; patients transferred from another acute care facility (only the first admission was counted); patients discharged alive with a total length of stay of less than three days; and patients older than 105 years of age.

Diabetes diagnosis

Patients with diabetes (excluding cases of gestational diabetes) were identified through the Quebec Diabetes Surveillance Database using the Canadian National Diabetes Surveillance System case definition (25). The Quebec Diabetes Surveillance Database is an administrative database that includes all persons with a diagnosis of diabetes in the province. Persons who enter the database remain until death or migration. Persons were classified as diabetic if they had at least one hospital admission or two primary care clinic visits with a diagnosis of diabetes (ICD-9 code 250) within a two-year period. This case definition was associated with a sensitivity of 94% and a positive predictive value of 88% (unpublished data), and was used by many Canadian provinces in numerous studies (4,15,26,27). Diabetes status was determined at the time of AMI discharge.

Outcomes

Coronary revascularization: Revascularization procedures during the index admission and within one year of admission were identified from any of the nine procedure codes using the hospital discharge database. Revascularization was considered to be performed during the index admission, even if patients were transferred to another acute care hospital to receive treatment. Revascularization at one year after AMI was estimated among survivors from their discharge. Two major coronary procedures were identified using the *Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures*: CABG (codes 48.10 to 48.19) and PCI (codes 48.02, 48.03 and 48.09). Because the exact date of referral to revascularization was not available in the administrative data, the time to revascularization was calculated from the date of the index AMI admission to the date of revascularization (28).

CFR (in-hospital and one year following AMI): In-hospital death was identified directly from the hospital database. Out-of-hospital death was determined by linking hospitalization data to the Quebec Death Certificate Registry database using unique anonymized patient identifiers. All-cause death was used to evaluate the mortality rate following AMI. However, CAD was the cause of 85% of in-hospital deaths and the cause of 78% of deaths within one year following an AMI.

Statistical analysis

Temporal changes in patient characteristics were tested using the Mantel-Haenszel χ^2 test for categorical data and simple linear regression for continuous variables. The age- and sex-adjusted CFRs, and proportion of patients who underwent revascularization procedures were calculated according to diabetes status and admission year. Proportions were adjusted using the direct method, according to the Quebec hospitalized AMI population in 2001. Age- and sex-adjusted geometric mean times to revascularization were calculated from the date of the index AMI admission to the date of revascularization because the variable followed a log-normal distribution. Analyses were performed using SAS version 9.1 (SAS Institute Inc, USA). Multiple log-binomial regression was used to assess the temporal trend in outcomes (revascularization or CFR). The COPY method was used to correct the problem of models that failed to converge (29). A two-sided $P<0.05$ was considered to be statistically significant. Models included diabetes status, age, sex, admission year as an ordinal variable and interaction terms between diabetic status and year to evaluate the differences in trends between patients with and without diabetes. Further analyses included additional comorbid conditions and hospital characteristics. Potential modifying effects of age, sex and type of facilities (hospital with or without invasive facility) on time trends of outcomes were tested by two-way interaction terms between year and each covariable. Only interaction with age (20 to 74 years and 75 years or older) was statistically significant in some outcomes. Variance inflation factors detected no significant colinearity between covariables. To verify whether the clustering of patients by hospitals affected the results, the analyses were repeated using the generalized estimating equation models; similar results were found. Consequently, they were not reported.

RESULTS

Baseline characteristics

The study population included 19,370 patients with diabetes and 58,182 without diabetes. Temporal changes in baseline characteristics of patients are presented in Table 1. In general, patients with diabetes were more likely to be older, to be women and to have more comorbid conditions than patients without diabetes. Between 1995 and 2001, the absolute number of incident AMIs decreased among patients without diabetes, while the number increased among patients with diabetes. The percentage of women with diabetes decreased while the percentage of women without diabetes increased slightly. The mean age and the proportion of patients 75 years of age or older increased over the study period, especially among patients with diabetes. The prevalence of most comorbid conditions documented during the previous two years before the index admission increased similarly in both groups. Patients with and without diabetes tended to be admitted more often to hospitals with onsite invasive facilities that had a high hospital volume.

Outcomes

Coronary revascularization: Temporal trends in the age- and sex-adjusted proportion of patients who underwent revascularization procedures and the percentage of annual change are presented in

TABLE 1
Baseline characteristics of patients with and without diabetes mellitus (DM) hospitalized for acute myocardial infarction according to fiscal year

Patients, n	Total	1995	1996	1997	1998	1999	2000	2001*	P for trend
DM	19,370	2503	2629	2779	2912	2923	3298	2326	
No DM	58,182	9324	9244	8839	8419	8150	8278	5928	
Demographic characteristics, %									
Female[†]									
DM	41.5	44.1	42.6	43.3	39.7	39.8	41.3	40.5	0.0011
No DM	32.4	31.5	31.7	32.2	32.5	32.8	33.0	33.5	0.0008
Age, years, mean ± SD									
DM	69.2±11.8	68.3±11.4	68.8±11.7	68.6±11.8	69.3±11.4	69.5±11.8	69.8±11.9	70±12.2	<0.0001
No DM	65.1±14.3	64.4±14.0	65.1±14.1	64.7±14.2	65.4±14.2	65.2±14.4	65.4±14.6	65.7±14.7	<0.0001
Age ≥75 years[‡]									
DM	36.4	31.5	34.6	34.0	36.1	38.2	39.2	40.8	<0.0001
No DM	29.6	27.0	29.1	28.2	30.2	30.1	31.5	32.5	<0.0001
Medical history, %[§]									
Heart failure									
DM	14.6	14.3	13.2	13.8	15.4	14.6	14.5	16.6	0.0097
No DM	6.4	5.3	6.4	6.4	6.5	6.5	6.6	7.3	<0.0001
Stroke									
DM	7.7	7.8	7.7	7.8	8.2	7.3	8.0	6.8	0.3564
No DM	3.5	3.4	3.4	3.4	3.5	3.6	3.7	3.6	0.1340
Chronic renal failure									
DM	15.2	11.6	13.0	12.8	14.6	15.7	18.6	20.0	<0.0001
No DM	6.7	5.5	5.6	6.0	6.7	7.2	8.2	8.8	<0.0001
Acute renal failure									
DM	3.8	3.2	3.0	3.8	3.5	3.7	4.1	5.6	<0.0001
No DM	1.2	1.1	1.2	1.2	1.4	1.1	1.4	1.0	0.6872
Peripheral arterial disease									
DM	16.6	16.2	14.8	16.0	16.1	17.2	17.5	18.1	0.0017
No DM	9.2	9.0	8.5	8.7	9.5	9.2	10.0	10.2	<0.0001
Cancer									
DM	6.3	4.7	5.6	5.5	5.4	6.6	7.2	9.0	<0.0001
No DM	3.4	3.0	3.1	3.3	3.6	3.3	3.7	4.2	<0.0001
Chronic pulmonary disease									
DM	21.3	19.2	19.9	20.4	21.7	22.0	21.7	24.5	<0.0001
No DM	16.4	15.1	15.7	16.4	16.4	16.4	16.8	18.5	<0.0001
Dementia									
DM	3.0	2.2	2.3	2.4	3.2	3.1	4.0	4.1	<0.0001
No DM	2.0	1.5	1.7	1.7	1.8	2.3	2.6	3.2	<0.0001
Previous PCI									
DM	1.5	1.0	1.1	1.2	1.4	2.0	1.8	2.0	<0.0001
No DM	0.9	0.4	0.6	1.0	1.0	1.1	1.3	1.2	<0.0001
Hospital characteristics, %									
Admission to hospitals with invasive facilities									
DM	19.7	14.2	21.5	20.5	21.4	21.6	20.2	17.1	0.0534
No DM	19.5	15.4	19.5	19.7	21.5	20.6	20.6	20.1	<0.0001
Hospital volume[¶]									
DM									<0.0001
<50	6.6	9.4	5.5	6.0	6.0	6.2	6.0	7.5	
50–139	22.7	31.4	22.8	20.0	20.0	22.7	20.3	22.7	
≥140	70.5	59.2	71.6	74.0	74.0	71.1	73.7	69.8	
No DM									<0.0001
<50	6.9	9.2	6.4	5.4	6.4	6.7	6.3	7.5	
50–139	24.6	33.4	23.2	22.5	21.0	23.1	23.1	25.0	
≥140	68.4	57.4	70.4	72.1	72.6	70.2	70.6	67.5	

**From April 1, 2001, to December 31, 2001; [†]P value for diabetes-year interaction was less than 0.0001; [‡]P value for diabetes-year interaction was equal to 0.0068; [§]Conditions were identified from the index back to two years before admission. Only diagnoses that clearly indicated chronic conditions were included in the index admission (to exclude all explicit codes for complications); [¶]Number of patients admitted with acute myocardial infarction per year. PCI Percutaneous coronary intervention*

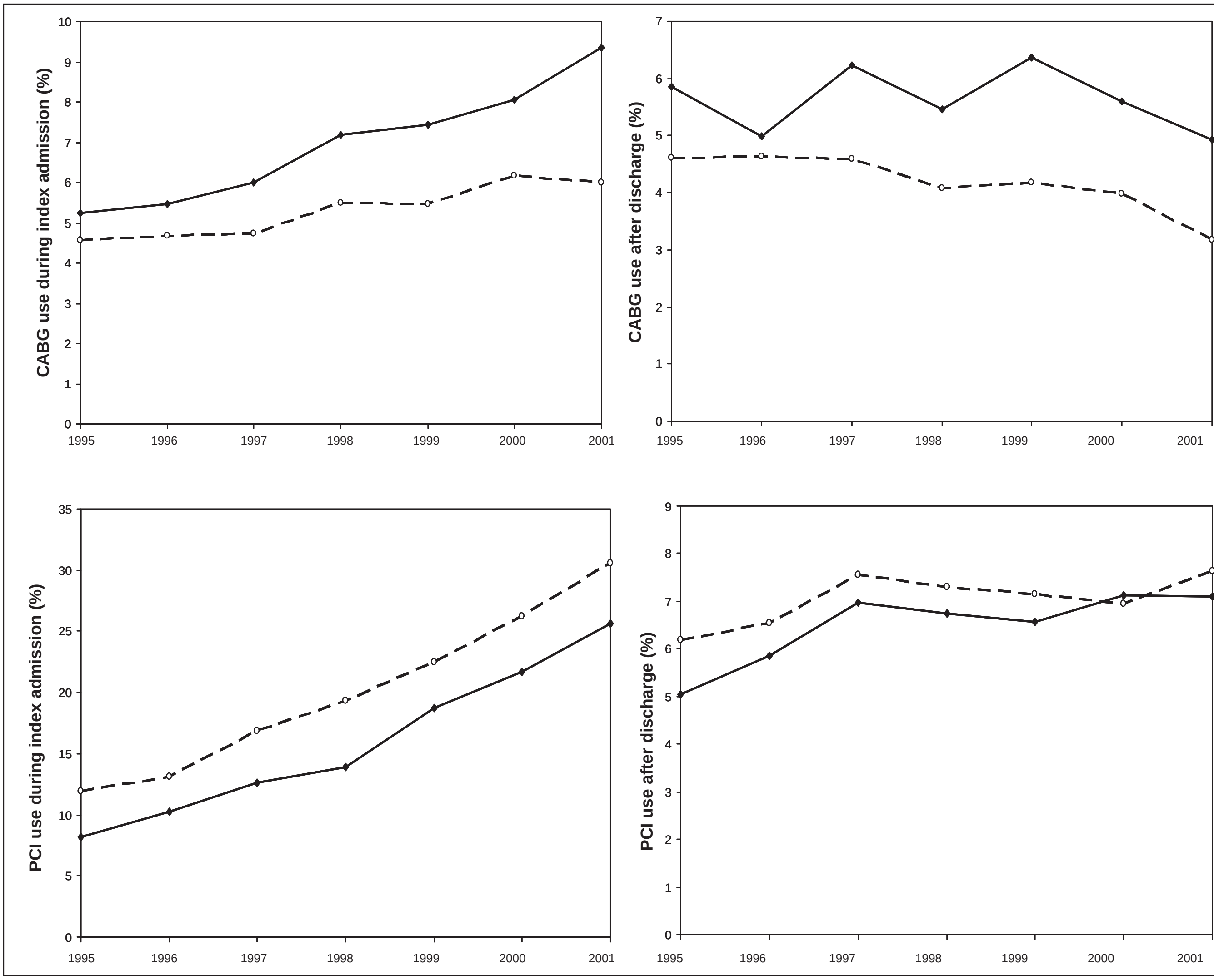

Figure 1) *Temporal changes in age- and sex-adjusted revascularization use in patients with and without diabetes. Solid line – diabetes; Dashed line – no diabetes. CABG Coronary artery bypass graft; PCI Percutaneous coronary intervention*

Figure 1 and Table 2. Overall, compared with patients without diabetes, those with diabetes were more likely to receive CABG (11.1% versus 8.3%; P<0.0001) but were less likely to receive PCI (17.1% versus 20.2%; P<0.0001) during the first year of index admission. The differential use of revascularization between patients with and without diabetes persisted after controlling for comorbid conditions and hospital characteristics (Table 2). The use of PCI increased substantially over time in both populations, driven mainly by an increase during the index admission (20.6% versus 16.6% per year; P=0.1144 in patients with and without diabetes, respectively). The use of CABG during the index admission increased markedly among patients with diabetes compared with those without (10.3% versus 5.3% per year, P=0.0072); however, at one year following discharge, CABG use remained stable in patients with diabetes and fell in those without (–0.7% versus –5.3% per year; P=0.2046). Results were similar after adjustment for comorbid conditions and hospital characteristics (Table 2). Patients 75 years of age or older underwent fewer revascularization procedures than younger patients (Figure 2), but they experienced a marked increase in revascularization procedures over time compared with younger patients with and without diabetes. Furthermore, the adjusted mean time to revascularization declined over the study period in both populations, except time to PCI after hospital discharge (Table 3).

CFR: Over the study period, there was a significant decline in age- and sex-adjusted CFR, especially during the index admission (Table 4). The decline was similar for patients with and without diabetes (P>0.05 for all diabetes-year interactions), but fatal outcome remained higher in patients with diabetes than in those without, with an overall adjusted RR of in-hospital mortality of 1.15 (95% CI 1.13 to 1.20) and 1.45 (95% CI 1.38 to 1.52) at one year following discharge. According to age, the one-year CFR decline was especially marked in younger patients (younger than 75 years) compared with the older ones among patients with diabetes (–4.5% versus –2.5% per year, P=0.0752) and especially without diabetes (–6.0% versus –2.4% per year, P=0.0004) (Figure 3). No different declines were observed between men and women in either population (data not shown).

DISCUSSION

The present study was the first in Quebec to compare the trends in post-AMI coronary revascularization use and CFR in patients with and without diabetes, and to evaluate changes in the characteristic profiles of these patients. Our data show that over the study period, patients with diabetes experienced a significant decline in CFR similar to patients without diabetes. This improvement paralleled a greater increase in early coronary revascularization procedures and a decrease in time to revascularization in this population.

TABLE 2
Temporal changes in revascularization use in patients with and without diabetes mellitus (DM)

	Age- and sex-adjusted revascularization use (%) and adjusted RR (95% CI) for DM vs no DM								Change	
	1995	1996	1997	1998	1999	2000	2001*	All years	% of annual change† (95% CI)	P‡
CABG use during index admission										
DM	5.2	5.5	5.8	7.3	7.4	8.0	9.3	6.9	+10.3 (7.4 to 13.3)	0.0072
No DM	4.5	4.6	4.7	5.5	5.4	6.1	6.0	5.2	+5.3 (3.4 to 7.2)	
Adjusted RR for DM vs no DM	1.19 (0.98–1.44)	1.26 (1.04–1.51)	1.39 (1.16–1.66)	1.35 (1.15–1.59)	1.48 (1.26–1.73)	1.46 (1.26–1.70)	1.75 (1.48–2.07)	1.41 (1.33–1.51)	–	0.0033
One-year CABG use after discharge§										
DM	5.8	4.9	6.2	5.4	6.3	5.5	4.9	5.6	–0.7 (–3.9 to 2.4)	0.2046
No DM	4.6	4.6	4.6	4.1	4.1	3.9	3.1	4.2	–5.3 (–7.3 to –3.3)	
Adjusted RR for DM vs no DM	1.33 (1.09–1.62)	1.14 (0.92–1.40)	1.36 (1.13–1.65)	1.46 (1.20–1.78)	1.62 (1.33–1.96)	1.42 (1.17–1.73)	1.52 (1.17–1.97)	1.40 (1.29–1.51)	–	0.1240
One-year CABG use										
DM	9.6	9.0	10.5	11.1	12.0	12.2	13.4	11.1	6.6 (4.4 to 8.9)	0.0006
No DM	8.1	8.2	8.3	8.5	8.4	8.8	7.9	8.3	0.08 (–1.3 to 1.4)	
Adjusted RR for DM vs no DM	1.22 (1.06–1.40)	1.19 (1.03–1.37)	1.35 (1.18–1.54)	1.40 (1.23–1.58)	1.52 (1.34–1.72)	1.49 (1.32–1.68)	1.77 (1.54–2.04)	1.41 (1.34–1.48)	–	0.0005
PCI use during index admission										
DM	8.1	10.1	12.8	13.7	18.6	21.6	25.6	15.8	+20.6 (18.4 to 22.9)	0.1144
No DM	11.9	13.1	16.8	19.2	22.5	26.1	30.5	19.2	+16.6 (15.6 to 17.6)	
Adjusted RR for DM vs no DM	0.74 (0.64–0.86)	0.79 (0.70–0.90)	0.75 (0.67–0.84)	0.78 (0.71–0.87)	0.85 (0.78–0.93)	0.89 (0.83–0.96)	0.89 (0.82–0.96)	0.84 (0.81–0.87)	–	0.0569
One-year PCI use after discharge§										
DM	5.0	5.8	6.9	6.8	6.5	7.1	7.1	6.4	+5.7 (2.5 to 9.1)	0.5991
No DM	6.1	6.5	7.5	7.3	7.1	6.9	7.6	7.0	+2.0 (0.5 to 3.6)	
Adjusted RR for DM vs no DM	0.81 (0.65–1.01)	0.89 (0.73–1.08)	0.88 (0.74–1.06)	0.92 (0.77–1.10)	0.92 (0.77–1.10)	1.03 (0.87–1.22)	0.96 (0.79–1.16)	0.92 (0.86–0.98)	–	0.5579
One-year PCI use										
DM	10.3	12.1	14.6	16.2	19.7	22.0	25.0	17.1	+16.3 (14.3 to 18.3)	0.1321
No DM	13.8	15.1	18.8	20.7	22.9	25.7	28.6	20.2	+12.2 (11.3 to 13.1)	
Adjusted RR for DM vs no DM	0.78 (0.68–0.89)	0.82 (0.73–0.93)	0.78 (0.70–0.87)	0.82 (0.75–0.91)	0.89 (0.82–0.98)	0.90 (0.83–0.98)	0.90 (0.83–0.99)	0.86 (0.83–0.89)	–	0.1091

**From April 1, 2001, to December 31, 2001; †Annual percentage of change = 100 × [exp (β)–1] adjusted for age and sex from log-binomial regression; ‡P value of diabetes-year interaction; §One-year revascularization following discharge excluding in-hospital deaths. CABG Coronary artery bypass graft; PCI Percutaneous coronary intervention; RR Relative risk adjusted for age, sex, medical history and hospital characteristics; vs Versus*

The profile of patients admitted for AMI changed between 1995 and 2001. Thus, the percentage of women with diabetes (a group at higher risk of CAD death) decreased over time, while age at admission increased. The prevalence of most comorbid conditions increased over time in parallel with increasing age, suggesting increases in the burden of these comorbid conditions. However, during the study period, a change in the diagnosis codes in administrative data could also have contributed to the increased prevalence of comorbidities.

Although several studies have investigated temporal changes in coronary revascularization following AMI (6,30,31), fewer have examined such changes with respect to diabetes status (17,18,32). Our data showed that patients with diabetes were more often referred for CABG surgery but less often referred for PCI than patients without diabetes. This result may reflect the higher prevalence of underlying multivessel CAD among patients with diabetes (33), which has been further emphasized by the results of the recently published Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI 2D) study (34). Despite available evidence from clinical trials, suggesting similar survival benefit between both modalities of revascularization in patients with diabetes (21,35,36), the five-year mortality rate after PCI remained higher among patients with diabetes than without (13.4% versus 6.8%; P=0.03), whereas, among those receiving CABG, the mortality rate was 8.3% versus 7.5%, respectively (P=0.8) (37). In addition, after PCI, patients with diabetes were more likely to develop

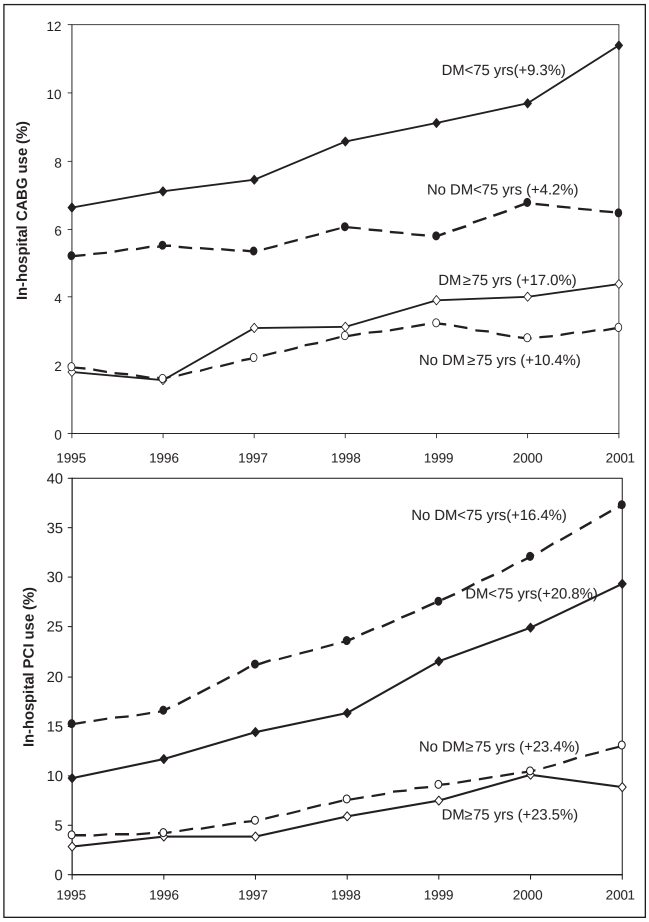

Figure 2) *Annual changes in hospital revascularization use by diabetic status and age group. All the P values for trends were less than 0.0001. CABG Coronary artery bypass graft; DM Diabetes mellitus; PCI Percutaneous coronary intervention; yrs Years*

new coronary lesions compared with patients without diabetes (38), and had a higher rate of restenosis and repeat revascularization than after CABG (35,39,40). Clearly, PCI remained less ideal in patients with diabetes with multivessel CAD.

Furthermore, our data showed that the use of CABG among patients with diabetes increased by 6.6% per year, while the use of PCI increased by 16% per year. Although CABG remains the recommended strategy for diabetic patients with multivessel CAD (41), recent advances in PCI (use of bare-metal and drug-eluting stents) have resulted in a changing paradigm for coronary revascularization procedures among patients with diabetes (19). The proportion of patients with diabetes who received PCI has increased (25.8%) compared with earlier percutaneous transluminal coronary angioplasty (balloon angioplasty) (13.4%) (42), which concord with the substantial increase in the use of PCI over time in the present large, observational study. The increase in revascularization use could have been the result of both increased capacity of the system and change in treatment. Because we did not have access to medical treatment data in our cohort, we can only speculate, in accordance with the literature, that the management of patients with acute coronary syndrome has changed. Also, in the present study, patients with and without diabetes tended to more often be admitted to hospitals with onsite invasive facilities with a high hospital volume. Such practice would, without a doubt, have favoured an interventional approach to myocardial infarction through the time period of our study. In addition, coronary revascularization plays an important role in the management of CAD in patients with diabetes. It has been shown to significantly reduce death compared with medical treatment in diabetic patients with stable multivessel CAD (21). However, this was not confirmed by the recent BARI 2D study (34). Reinforcement of early therapeutic approaches in patients with diabetes has been shown to be important for reducing in-hospital mortality in this population (43). Our data provide evidence of implementation of these findings into practice, which could have contributed to improved survival.

Consistent with our results, the Sweden study (17) showed a 100% increase in revascularization less than 14 days following AMI from 1995 to 2002. In Ontario (32), the use of CABG and PCI increased by 20% and 50%, respectively, between 1995 and 1999. Investigations in the United States (18) and Sweden (17) noted a modest change in revascularization procedure use in patients with diabetes, most likely because they reported changes at an earlier time period (1990 to 1995) than that of our study. However, our study provides additional information regarding these changes both in-hospital and one year following discharge. We were also able to adjust for patient and hospital characteristics, and examine the diabetes-year interaction, which were not performed in all previous studies.

Favourable changes in mortality rates in patients with diabetes have been reported by recent investigations. There was a 44% reduction in in-hospital mortality following AMI between 1992 and 1999 in Ontario (15). A similar decline in the one-year mortality rate between patients with and without diabetes was also noted in the United States from 1990 to 1997 (16), in Sweden from 1995 to 2002 (17) and in the United Kingdom from 1995 to 2003 (44). Moreover, our data indicate that, in both populations, the one-year postdischarge CFR decline was less pronounced than that during hospital admission. Long-term mortality rate following AMI was related to recurrent events that were stable over time (data not shown). This may have contributed to a lesser decline in one-year CFR. Furthermore, in accordance with previous studies (15), we observed that patients 75 years of age or older had a less favourable decline in mortality rate than younger patients (Figure 3). Despite a significant increase in revascularization procedure use over time (Figure 2), older patients benefit less from interventional and medical management (45). Other studies reported that discharge prescriptions for acetylsalicylic acid, beta-blockers and angiotensin-converting enzyme inhibitors were not provided to 12.6%, 19.7% and 25.2% of ideal candidates, respectively, who were older than 65 years of age in 2000/2001 (5), despite evidence suggesting that they could benefit greatly from such treatments (46). On the other hand, older patients hospitalized for AMI had more frequent in-hospital adverse events, a greater burden of comorbidity and more frequent contraindications to medical treatment (5). All of these factors may contribute to their only modest improvement in survival.

CFR decline suggests an improvement in management and treatment of patients with diabetes. Control of cardiovascular risk factors, such as smoking cessation, blood pressure and cholesterol levels, is important in the management of patients with diabetes (47,48). Previous studies in Quebec (49) and elsewhere (17,44) have reported improvement in medical therapy (in-hospital and at discharge), including beta-blockers, angiotensin-converting enzyme inhibitors and hypolipidemic therapy, in patients with diabetes. Even so, these treatments were still less frequently prescribed for patients with diabetes (13).

Limitations

Our study has some limitations. First, use of administrative data may lead to misclassification. However, it is unlikely that such errors would occur differentially according to diabetes status or study year. Second, patients with a previous AMI in the four years before the index admission were excluded. Nevertheless, this length of time may not be sufficiently long to identify first AMI events. Third, our database did not include certain important factors such as pharmacological therapy and clinical characteristics, which could have contributed to the observed decline in CFR. Fourth, a potential bias may be due to changes in the diagnostic criteria for AMI following the introduction of troponin markers in the year 2000, which enable diagnosis of less severe cardiac damage (50).

TABLE 3
Temporal changes in time to revascularization within one year following acute myocardial infarction according to diabetic status

	Age- and sex-adjusted mean time to revascularization (days)*							Change	
	1995	1996	1997	1998	1999	2000	2001†	% of annual change‡ (95% CI)	P§
Time to CABG (during index admission)									0.5291
DM	18.3	17.7	16.5	16.3	16.9	14.4	15.6	–3.0 (–5.2 to –0.7)	
No DM	17.0	17.5	15.7	13.4	14.6	13.2	12.8	–4.9 (–6.3 to –3.5)	
Time to CABG (after discharge)									0.0001
DM	84.2	71.2	54.7	61.1	59.2	54.0	31.2	–10.5 (–14.2 to –6.7)	
No DM	77.6	85.9	77.1	78.8	63.2	74.9	68.8	–3.0 (–5.8 to –0.7)	
Time to PCI (during index admission)									0.0451
DM	6.1	4.5	4.2	4.7	4.6	3.8	3.3	–5.6 (–7.6 to –3.5)	
No DM	5.6	5.0	5.0	4.5	4.0	3.9	3.0	–7.1 (–8.0 to –6.2)	
Time to PCI (after discharge)									0.4118
DM	67.1	76.1	62.8	71.6	68.2	70.2	61.5	–0.8 (–4.4 to 2.8)	
No DM	71.1	70.1	66.0	64.5	62.6	58.5	67.7	–2.2 (–3.9 to –0.5)	

**Time to revascularization = adjusted geometric mean from date of the index acute myocardial infarction to procedure; †From April 1, 2001, to December 31, 2001; ‡Annual percentage of change = 100 × [exp (β)–1] adjusted for age and sex from linear regression models; §P value of diabetes-year interaction. CABG Coronary artery bypass graft; DM Diabetes mellitus; PCI Percutaneous coronary intervention*

TABLE 4
Temporal changes in case fatality rate (CFR) in patients with and without diabetes mellitus (DM)

	Age- and sex-adjusted CFR (%) and adjusted RR (95% CI) for DM vs no DM								Change	
Outcomes	1995	1996	1997	1998	1999	2000	2001*	All years	% of annual change† (95% CI)	P‡
In-hospital CFR										
DM	15.1	13.1	16.4	13.5	13.4	11.9	11.2	13.5	–5.0 (–6.7 to –3.4)	0.2820
No DM	12.2	11.7	10.8	10.8	10.7	9.7	8.8	10.8	–4.1 (–5.3 to –3.0)	
Adjusted RR for DM vs no DM	1.15 (1.05–1.27)	1.05 (1.00–1.16)	1.39 (1.27–1.53)	1.13 (1.03–1.25)	1.09 (1.00–1.21)	1.13 (1.02–1.25)	1.11 (1.00–1.25)	1.15 (1.11–1.20)	–	0.1488
One-year CFR postdischarge										
DM	13.7	14.1	13.8	14.3	12.1	11.8	11.9	13.1	–2.5 (–4.4 to –0.6)	0.6294
No DM	7.4	7.3	7.4	6.4	6.7	6.4	6.1	7.0	–2.5 (–4.1 to –0.8)	
Adjusted RR for DM vs no DM	1.54 (1.35–1.75)	1.48 (1.31–1.68)	1.45 (1.28–1.65)	1.72 (1.52–1.96)	1.33 (1.16–1.52)	1.35 (1.20–1.52)	1.45 (1.24–1.68)	1.45 (1.38–1.52)	–	0.7738
One-year CFR										
DM	25.6	24.6	26.8	25.1	23.2	21.4	21.1	24.0	–3.1 (–4.2 to –2.0)	0.1116
No DM	18.2	17.6	16.8	16.0	16.2	15.0	13.9	16.4	–3.1 (–4.0 to –2.2)	
Adjusted RR for DM vs no DM	1.21 (1.12–1.29)	1.17 (1.09–1.25)	1.31 (1.23–1.40)	1.22 (1.14–1.30)	1.14 (1.06–1.23)	1.16 (1.08–1.25)	1.20 (1.10–1.30)	1.21 (1.18–1.24)	–	0.2361

**From April 1, 2001, to December 31, 2001; †Annual percentage of change = 100 × [1–1/exp (β)] adjusted for age and sex from log-binomial regression; ‡P value of diabetes-year interaction. CFR is the number of deaths/number of admitted patients; RR Relative risk adjusted for age, sex and medical history; vs Versus*

All the same, this would have affected only the last two years of our data, whereas the observed change in outcomes was relatively stable over time. Fifth, prehospital death (before being admitted to the hospital) could not be recorded. However, a previous study evaluating out-of-hospital death (51) also reported a significant decline in mortality rate following AMI. Sixth, our data did not include out-of-hospital PCI use. However, such use was relatively rare during our study period. Seventh, in the present study, the mean length of hospital stay decreased significantly from 13.2 days in 1995 to 12.0 days in 2002 among patients with diabetes, and from 11.7 days to 10.2 days among patients without diabetes (data not shown). This decline in length of hospital stay, however, has a minor effect on in-hospital CFR. Even when we considered a fixed time interval by examining temporal changes in 30-day CFR, we found a similar decline to that of in-hospital CFR; it was 4.6% and 4.8% per year in patients with and without diabetes, respectively (data not shown). Finally, the present study was limited to a period between

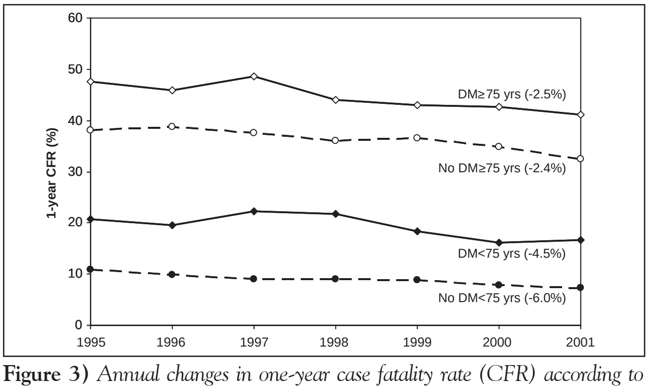

Figure 3) *Annual changes in one-year case fatality rate (CFR) according to diabetic status and age group. All the P values for trends were less than 0.0001, except for diabetes mellitus (DM) 75 years (yrs) of age or older (P=0.0002)*

1995 and 2001. Some important changes in practice have taken place in the current era. Hence, more current data are necessary to examine contemporary trends.

CONCLUSION

Our data provide evidence of favourable changes in clinical practice regarding coronary revascularization procedures in a population with diabetes. These changes were accompanied by significant decreases in CFR of the same magnitude as patients without diabetes. These findings were observed despite increases over time in the prevalence of comorbidities and age at admission. Nevertheless, the burden of diabetes on mortality remains high compared with patients without diabetes. This persistent higher mortality risk and the global increasing prevalence of diabetes in Quebec highlight the need to expand effective strategies to improve the prevention and management of diabetes and cardiovascular disease complications to improve the poorer prognosis in this population.

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