Changes in the treatment and outcomes of acute myocardial infarction in Quebec, 1988–1995

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Abstract

Background: Few studies have reported population-based information on the treatment trends and outcomes of patients who have had an acute myocardial infarction (AMI). We therefore examined patterns of care and outcomes for AMI patients in Quebec, Canada, between 1988 and 1995.

Methods: Longitudinal data files of hospital admissions in Quebec (Med-Echo database) and inpatient and outpatient services (Régie de l'Assurance Maladie du Québec database) were used to construct cohorts of all AMI patients in the province between 1988 and 1995. Temporal trends in the use of cardiac procedures after an AMI, discharge prescriptions and mortality rates were examined.

Results: Between 1988 and 1995 the age- and sex-adjusted rates of AMI in the Quebec population declined (148 per 100 000 in 1988 to 137 per 100 000 in 1995). The use of intensive cardiac procedures increased in the same period; the 1-year cumulative incidence rate of catheterization increased from 28% in 1988 to 31% in 1994, that of angioplasty rose from 8% to 15% and that of coronary artery bypass surgery from 6% to 8%. Prescriptions for ASA, β-blockers, lipid-lowering agents and angiotensin-converting enzyme inhibitors increased, and prescriptions for nitrates and calcium antagonists decreased. These temporal changes were paralleled by a decrease in mortality rates post-AMI. All-cause 1-year cumulative incidence mortality rates decreased from 23% in 1988 to 19% in 1994.

Interpretation: The decrease in AMI-related mortality in Quebec between 1988 and 1995 may be linked to changes in treatment strategies (i.e., increased use of cardiac surgical procedures and medications shown to increase survival).

Marked international and regional variations in the treatment of acute myocardial infarction (AMI) have been reported,[1–8] and the reasons for these variations and the differential outcomes have been investigated.[9–12] Many studies of AMI patients have used convenience samples of patients or patients selected for enrollment on the basis of inclusion criteria for randomized clinical trials. Very few studies have reported information on a population-wide process of care and outcomes for a given medical condition.

Using detailed longitudinal administrative data we analyzed recent changes in medical treatment patterns and patient health outcomes for all patients from the province of Quebec who had an AMI between 1988 and 1995. Our aim was to document how the care of AMI patients has changed in Quebec over time and to suggest some possible determinants of these trends.

Methods

The hospital discharge summary database in Quebec, Med-Echo, which provides universal information on hospital admissions, was used to construct annual cohorts of patients admitted to hospital because of an AMI between Jan. 1, 1988, and Dec. 31, 1995. We included patients in the AMI cohorts if they had been admitted to hospital for a main diagnosis of AMI (*International Classification of Diseases*, 9th rev. code 410) during the study period; patients who had a previous AMI in the preceding 3 years were excluded.

Research

Recherche

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We also used Med-Echo data to identify patients who were admitted to hospital after the index AMI for a recurrent AMI or congestive heart failure. For each of these patients we chronologically ordered the related admissions and recorded their duration. We excluded any admissions within 30 days of the initial AMI because they were likely to represent readmissions for the treatment of the index AMI rather than later complications.

We used the Quebec Medicare database, the Régie de l'Assurance Maladie du Québec (RAMQ), to assess patterns of treatment. This administrative database contains records on all diagnostic and therapeutic procedures, both inpatient and outpatient, performed in Quebec, as well as drug prescriptions for all individuals 65 years of age and older and for welfare recipients. For the AMI cohorts we obtained RAMQ records for surgical procedures between Jan. 1, 1988, and Dec. 31, 1995, and for drug prescriptions written between Jan. 1, 1991, and Dec. 31, 1995. Cardiac procedures included catheterization only, catheterization and angioplasty, and catheterization and coronary artery bypass surgery. Cardiac medications prescribed post-AMI included angiotensin-converting enzyme inhibitors, ASA, β-blockers, lipid-lowering agents, nitrates and calcium-channel antagonists. The first 4 have been shown to improve survival after AMI, whereas calcium-channel antagonists may be harmful after AMI.[13,14]

To assess the vital status of the AMI patients we used both Med-Echo and RAMQ data. The all-cause mortality variable is coded in Med-Echo only if a patient dies in the hospital, while the RAMQ mortality variable is built on death certification that can occur out of hospital. This latter variable is constructed by comparing vital status information provided by Quebec institutions that manage pensions and car insurance; a date of death exists in the RAMQ data only if the 2 institutions agree on mortality status. In addition, a RAMQ code for death certification and the date of the latest medical treatment are included. Using all sources of information to document mortality in our data we built an algorithm intended to maximize the reliability of the vital status variable; through this algorithm we determined the vital status in 99.75% of the AMI patients in our database.

Cumulative incidence rates were standardized using the age and sex distribution of the 1995 population. For the 1-year cumulative incidence rates, the 1995 population was not included because the 1-year follow-up data were not available.

Results

The age- and sex-adjusted cumulative incidence rates of a first AMI in the Quebec population declined (148 per 100 000 in 1988 to 137 per 100 000 in 1995) during the study period, and this decline was apparent for both men and women. The mean age and sex distribution of AMI patients remained constant over time, however (Table 1). In 1995 there were 16 sites that provided catheterization and 12 sites that provided both angioplasty and coronary artery bypass surgery as well. These sites served a population of 7.3 million and treated close to 10 000 AMI patients per year. Angioplasty was performed without surgical backup

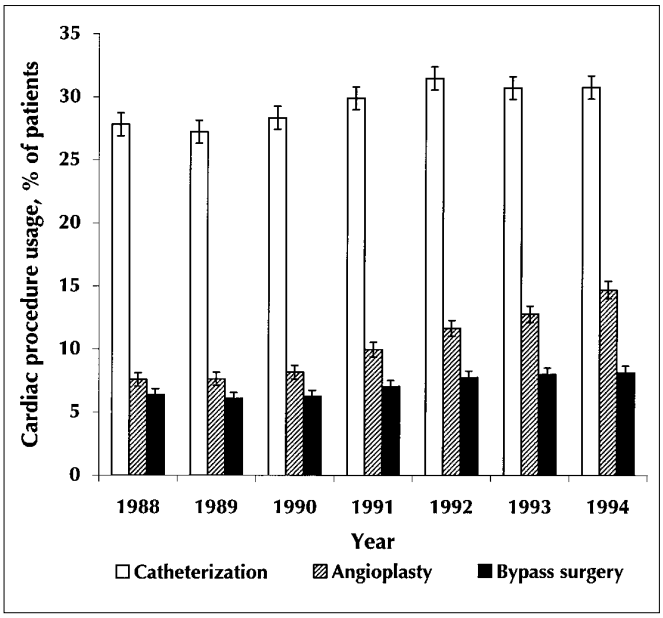

Fig. 1: One-year cumulative incidence rates (and 95% CI) of catheterization, angioplasty and coronary artery bypass surgery between 1988 and 1994. Rates are adjusted for the age and sex distribution of the 1995 AMI patient population.

Table 1: Characteristics of patients in Quebec experiencing their first acute myocardial infarction, 1988–1995

Characteristic	1988	1989	1990	1991	1992	1993	1994	1995
No. of patients	8 995	8 995	9 143	9 594	9 688	9 728	9 790	10 079
Median age at index AMI, yr	65	65	65	66	66	66	66	66
Male, %	67	66	66	66	66	66	66	66
Age-adjusted yearly incidence of AMI per 100 000								
Males	198	192	190	193	189	185	183	183
Females	98	95	95	98	98	95	92	93
No. of hospitals providing each procedure								
Catheterization	12	12	12	15	15	15	15	16
Angioplasty	11	11	11	12	12	12	12	12
Coronary artery bypass surgery	9	10	10	12	12	12	12	12

Note: AMI = acute myocardial infarction.

at 2 sites in 1988 and at 1 site in both 1989 and 1990.

The 1-year cumulative incidence rate of catheterization was 28% in 1988 and 31% in 1994 (Fig. 1). The increase in the catheterization rate over time was greater, in both absolute and relative terms, in the time span shortly after the index AMI (data not shown). For example, the proportion of patients undergoing catheterization within 7 days of the index AMI increased from less than 8% before 1991 to 12% in 1995. Along these lines, by 1994 over 71% of catheterizations performed within the first year were done within 30 days of the index AMI. Rates of revascularization followed similar trends. The 1-year cumulative incidence of angioplasty rose from 8% in 1988 to 15% in 1994 and that of coronary artery bypass surgery from 6% to 8% (Fig. 1).

Table 2: One-year cumulative incidence rates of use of cardiac procedures in AMI patients in Quebec, 1988–1994

Procedure, characteristic	Rate, % (and 95% CI) of patients*						
	1988	1989	1990	1991	1992	1993	1994
Catheterization							
Male							
Age ≥ 65	17 (15–18)	17 (15–18)	18 (16–19)	20 (18–21)	23 (21–24)	24 (22–25)	24 (23–26)
Age < 65	43 (41–45)	43 (41–44)	43 (41–45)	44 (43–46)	47 (45–48)	43 (42–45)	43 (41–44)
Female							
Age ≥ 65	11 (10–12)	11 (10–12)	13 (12–15)	14 (13–16)	16 (14–17)	16 (14–17)	16 (14–17)
Age < 65	38 (35–42)	36 (33–39)	39 (36–42)	44 (41–48)	43 (40–47)	42 (39–45)	43 (40–46)
Overall	28 (27–29)	27 (26–28)	28 (27–29)	30 (29–31)	31 (31–32)	31 (30–32)	31 (30–32)
Angioplasty							
Male							
Age ≥ 65	4 (3–5)	4 (3–4)	4 (3–5)	5 (5–6)	6 (6–7)	8 (7–9)	9 (8–10)
Age < 65	12 (11–13)	13 (12–14)	13 (12–15)	16 (15–17)	19 (17–20)	20 (18–21)	22 (21–23)
Female							
Age ≥ 65	3 (2–3)	3 (2–4)	3 (3–4)	5 (4–5)	6 (5–7)	7 (6–8)	8 (7–9)
Age < 65	12 (10–15)	11 (9–14)	13 (11–15)	15 (13–18)	17 (15–20)	17 (15–20)	22 (19–25)
Overall	8 (7–8)	8 (7–8)	8 (8–9)	10 (911)	12 (11–12)	13 (12–13)	15 (14–15)
Coronary Artery Bypass Surgery							
Male							
Age ≥ 65	5 (4–6)	5 (4–6)	5 (4–6)	6 (5–7)	7 (6–8)	8 (7–9)	8 (7–9)
Age < 65	9 (8–10)	9 (8–10)	9 (8–10)	9 (9–10)	11 (10–13)	10 (9–11)	10 (9–11)
Female							
Age ≥ 65	3 (3–4)	3 (2–4)	4 (3–5)	4 (3–5)	4 (3–5)	4 (4–5)	5 (4–6)
Age < 65	7 (6–9)	7 (5–8)	7 (5–8)	9 (7–11)	7 (6–9)	8 (7–10)	10 (8–12)
Overall	6 (6–7)	6 (6–7)	6 (6–7)	7 (7–8)	8 (7–8)	8 (7–9)	8 (8–9)

Note: CI = conficence interval.
*For the total number of patients in each AMI cohort see Table 1.

Table 3: Discharge prescriptions for cardiac medications, 1991–1995

Prescribed drug	% (and 95% CI) of patients				
	1991 *n = 4094*	1992 *n = 4252*	1993 *n = 4235*	1994 *n = 4239*	1995 *n = 3129**
ASA	65 (63–66)	66 (65–68)	66 (64–67)	66 (64–67)	67 (65–68)
β-Blocker	33 (31–34)	38 (36–39)	43 (41–44)	47 (45–48)	50 (48–52)
Calcium-channel antagonist	41 (40–43)	38 (37–39)	35 (34–36)	32 (31–34)	31 (29–32)
Nitrates	65 (63–66)	63 (62–65)	62 (61–64)	62 (60–63)	60 (59–62)
ACE inhibitor	33 (32–35)	36 (34–37)	34 (33–36)	37 (35–38)	41 (40–43)
Lipid-lowering agent	5 (4–6)	7 (6–7)	7 (6–8)	9 (9–10)	13 (12–14)

Note: CI = confidence interval, ACE = angiotensin-converting enzyme.
Data unavailable for 1988–1990.
*Does not include patients with AMI after Oct. 1, 1995.

These trends in procedure utilization were seen for both age groups and both sexes (Table 2). For catheterization procedures the increase was greatest for older men and for all women regardless of age. For angioplasty, increments were seen across all groups but were greatest among younger (i.e., < 65 years of age) men and women. The increases were modest across all groups for bypass surgery.

Discharge prescriptions for cardiac medication also changed over time (Table 3). Prescriptions for ASA, β-blockers, lipid-lowering agents and angiotensin-converting enzyme inhibitors increased between 1991 and 1995, and those for nitrates and calcium-channel antagonists decreased.

The increase in the use of various cardiac procedures was paralleled by a decrease in average age- and sex-adjusted mortality rates (adjusted for the 1995 population). All-cause 1-year mortality rates decreased from 23% in 1988 to 19% in 1994 (Table 4). Between 1988 and 1995 the inhospital mortality rate declined from 14% to 11% and 30-day mortality declined from 15% to 12% (Fig. 2). The decline was seen for both men and women and across different age groups. The average post-angioplasty 30-day mortality rate was not higher between 1988 and 1990, when some institutions did not have onsite surgical backup (i.e., 1.6% 1988–1990 v. 2.4% 1992–1994).

Interpretation

Mortality from AMI among patients in Quebec decreased between 1988 and 1995, but the median age at the index AMI and the percentage of men and women in the AMI cohorts remained constant over time. During the same period the use of cardiac procedures including catheterization, angioplasty and coronary artery bypass surgery increased; as well, the number of prescriptions for cardiac medications shown to increase survival after AMI increased, while that of medications with no or deleterious effects on survival decreased. Not only did the rate of invasive treatments increase over time, but more patients received these treatments in a progressively shorter time after AMI onset.

The decrease in AMI-related mortality in Quebec may have resulted from changes in treatment. Published data on medication use after AMI are scarce; however, comparisons with reports from the United States[15–18] suggest that the percentage of AMI patients in Quebec who were discharged with prescriptions for cardiac medication is higher than that reported for patients in the US. For example, data from the United States National Registry on Myocardial Infarction show that in 1995, 28% of AMI patients 65 years of age and older were given a discharge prescription for an angiotensin-converting enzyme inhibitor;[15] 41% of comparable patients from Quebec were discharged with the same prescription.

In contrast, the rates of invasive cardiac procedures are lower in Canada than in the United States.[2,7,8] Despite these differences, previous reports have shown similar decreases in mortality rates in the 2 regions.[1,2,7,8] Whether the increased use of cardiac procedures and medications in Que-

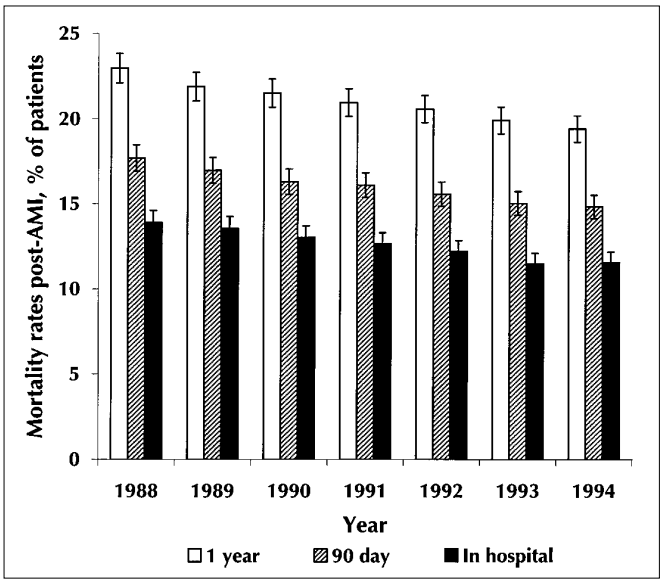

Fig. 2: Cumulative incidence (and 95% CI) of mortality rates between 1988 and 1994, by time after acute myocardial infarction. Rates are adjusted for the age and sex distribution of the 1995 AMI patient population.

Table 4: One-year cumulative incidence rates of mortality after a first acute myocardial infarction

	% (and 95% CI) of patients*						
Characteristic	1988	1989	1990	1991	1992	1993	1994
Male							
Age ≥ 65	32 (30–34)	33 (31–35)	31 (29–33)	29 (28–31)	29 (28–31)	27 (26–29)	27 (26–29)
Age < 65	10 (9–11)	8 (7–9)	8 (7–9)	7 (6–8)	7 (6–8)	6 (5–7)	6 (5–6)
Female							
Age ≥ 65	39 (37–41)	36 (34–38)	36 (34–38)	36 (34–38)	34 (32–36)	36 (34–38)	34 (32–36)
Age < 65	13 (11–15)	12 (10–14)	12 (10–15)	12 (10–14)	11 (9–13)	10 (8–12)	11 (9–13)
Overall	23 (22–24)	22 (21–23)	21 (21–22)	21 (20–22)	21 (20–22)	20 (19–21)	19 (19–20)

Note: CI = confidence interval.
*For total number of patients each year refer to Table 1.

bec has had a positive impact on mortality rates remains to be determined.

In 1991, when the sharpest rise in the use of procedures occurred in Quebec, there were 3 additional hospitals able to perform catheterization, 1 new site able to perform angioplasty and 2 new sites able to perform coronary artery bypass surgery. Thus, the addition of new facilities offering cardiac procedures and a more efficient transfer of patients between hospitals may have contributed to the increase in the proportion of patients receiving those procedures. Still, during the study period, only a small proportion of patients who had an AMI was admitted to a hospital where catheterization and coronary revascularization procedures were available. In 1995 only 18% of AMI patients were admitted to hospitals where angioplasty or coronary artery bypass surgery could be done and 23% to sites where only catheterization was available.

Compared with data from Ontario,[19] these trends in procedure use and outcome were similar. For example, the use of catheterization was the same (overall 26.2% in 1992 to 31.7% in 1996), that of angioplasty slightly lower in Ontario (6.3%–9.2%) and that of bypass surgery slightly higher in Ontario (8.4%–10.5%).

However, compared with the United States, changes in procedure utilization in Quebec before and after 1991 are somewhat modest, likely because of characteristics of the health care systems. There is evidence that in Quebec the regulatory and financial incentives particular to the health care system have had important effects on the treatment of AMI patients. For example, because hospital reimbursement in Quebec is based on global budgets, hospitals have important incentives to use intensive treatments sparingly. In addition, there is little financial incentive for physicians to perform more surgical procedures. Indeed, physicians' reimbursement for intensive procedures has changed minimally over time and has perhaps even declined if inflation is taken into account. Finally, although intensive cardiac technology has diffused to additional sites, it is still tightly controlled relative to the United States.

The descriptive nature of this study limits our ability to relate changes in AMI treatment to changes in AMI-related outcomes. In addition, we do not know how accurately we identified all patients in Quebec during the study period who experienced their first AMI. To identify first-AMI patients, we were able to exclude most patients who had sustained an AMI in the 3-year period preceding our study time frame, but it is possible that some patients may have had an AMI previous to this, and they would not have been excluded. However, the percentage of individuals misclassified as having a "first" AMI is unlikely to change over years or to affect the temporal trends. Also, because our patient identification was based on discharge summary data (MedEcho), patients who died of an AMI in the emergency room before being admitted to a hospital were not included in the study. Although this may have led to an underestimate of the total number of AMIs in Quebec, it is unlikely this underestimate varied over time or involved a large number of people — in general, patients with an AMI are quickly admitted to a monitored setting. Finally, information on the use of thrombolytic therapy is not accessible through this database because inpatient medications are part of a hospital's budget and their use is not itemized. Thus, an increase in the use of thrombolytic therapy over time could also be responsible for the observed decline in mortality.

The care of AMI patients is becoming increasingly technological and costly. Whether a more aggressive use of expensive treatment strategies for AMI is cost-effective is unknown at this time. The overuse and the underuse of these procedures is likely region-specific, but from a local point of view, it is important for Quebec physicians, health administrators and politicians to see where local practice patterns stand in the broad spectrum. From an international point of view, these data provide additional points on the curve to determine when underuse leads to poor outcome and overuse to diminishing returns. Although no definitive conclusions can be drawn from these data, they provide additional population-based trends on the use of cardiac procedures and mortality rates after AMI. Worldwide, only the Medicare databases in the United States for individuals 65 years of age and older and the databases from Canadian provinces can provide detailed, albeit descriptive, analyses at the population level.

The dissemination of cardiac procedures and the use of evidence-based cardiac medications for the treatment of patients with AMI have increased modestly between 1988 and 1995 in Quebec. There has also been a decline in mortality. Whether the two are related remains unclear, however.

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