Component of Statistics Canada Catalogue no. 82-003-X
Health Reports

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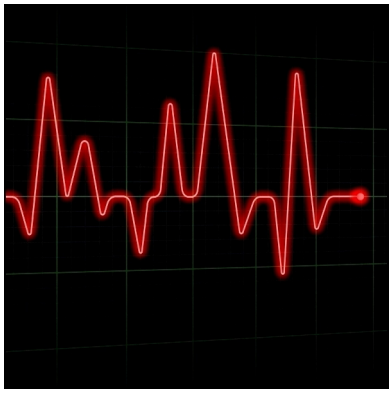

by Helen Johansen, Julie Bernier, Philippe Finès, Susan Brien, William Ghali and Michael Wolfson for the Canadian Cardiovascular Outcomes Research Team

May, 2009

Statistics Canada Statistique Canada

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Variations by health region in treatment and survival after heart attack

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Abstract

This article examines geographical variations in 30-day revascularization rates and 30-day in-hospital mortality rates for Canadian heart attack (acute myocardial infarction) patients. The data are from the Health Person-Oriented Information Database and pertain to health regions with at least 100,000 population in seven provinces for the years 1995/1996 and 2003/2004. Revascularization rates rose in all health regions between these years, and mortality rates dropped in most, but not all, regions. Generally, health regions with high revascularization rates had lower mortality rates. However, some regions with high revascularization rates had relatively high mortality rates, and some with relatively low revascularization rates achieved relatively low mortality rates. These results raise important questions about the overall efficiency of health care in Canada, and suggest that better data are needed to support research on explaining the wide geographical variations in treatment and survival rates for heart attack patients.

Keywords

coronary artery bypass, mortality, myocardial infarction, percutaneous coronary intervention, revascularization, small area variations

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Substantial variations in the nature, extent and availability of health care across geographical areas,[1,2] without any clear association with outcomes, have long been observed. Two decades ago, such variations in the United States led to calls for guidelines to determine appropriateness in the delivery of services. Investments were made in Patient Outcome Review Teams[3-6] to develop clinical guidelines for deciding when a given surgical procedure or diagnostic imaging study is warranted. The underlying premise was that the wide variations might indicate that health care was being provided based on different protocols or with different benefits to patients.

This article presents data on geographical variations, so-called small area variations,[1,2] in treatment and outcomes for heart attack (acute myocardial infarction) patients in Canada. Beyond simply showing that treatments—in this case, rates of revascularization—vary a great deal across subprovincial health regions,[7-10] this study juxtaposes revascularization rates against a fundamental outcome: 30-day mortality (see *The data*).

Revascularization rising/ Mortality falling

Overall, among acute myocardial infarction patients in the 46 health regions examined, revascularization rates rose and mortality rates fell between 1995/1996 and 2003/2004. The mean percentage who were revascularized within 30 days of hospital admission tripled from 12.8% to 39.8%, and the mean 30-day mortality rate dropped from 13.2% to 9.4% (Table 1).

Table 1
Age-sex standardized 30-day revascularization and 30-day mortality rates of acute myocardial infarction patients, health regions with at least 100,000 population, seven provinces,† 1995/1996 and 2003/2004

Classification of health region by Section‡ in 1995/1996	Age-sex standardized 30-day revascularization rate			Age-sex standardized 30-day mortality rate			Section‡	
	1995/1996	2003/2004	Difference	1995/1996	2003/2004	Difference	1995/1996	2003/2004
1	9.8	28.4	18.6	11.8	8.6	-3.2	A	A
2	5.7	29.7	24.1	12.6	9.1	-3.5	A	A
3	7.6	32.6	25.0	12.3	9.1	-3.1	A	A
4	9.0	43.1	34.1	11.6	8.3	-3.2	A	B
5	4.9	20.8	15.8	11.5	12.7	1.2	A	C
6	7.4	38.6	31.2	12.4	9.8	-2.6	A	C
7	7.1	28.1	21.0	11.8	10.4	-1.4	A	C
8	7.8	37.2	29.3	12.9	10.1	-2.8	A	C
9	2.0	26.3	24.3	8.0	9.9	1.8	A	C
10	11.9	29.8	17.9	7.5	9.4	1.9	B	A
11	19.2	38.5	19.3	11.4	8.8	-2.6	B	A
12	22.0	44.1	22.1	9.3	6.9	-2.4	B	B
13	17.6	42.4	24.8	11.9	9.2	-2.7	B	B
14	14.7	41.8	27.1	12.3	9.1	-3.2	B	B
15	23.6	57.9	34.3	12.8	8.7	-4.1	B	B
16	20.1	48.6	28.5	12.8	7.5	-5.3	B	B
17	19.9	42.3	22.3	9.4	8.5	-0.9	B	B
18	31.9	57.8	25.8	11.3	5.5	-5.8	B	B
19	24.9	53.9	29.1	12.7	6.8	-5.8	B	B
20	13.8	42.5	28.7	12.2	6.3	-5.9	B	B
21	17.6	37.0	19.4	11.4	10.9	-0.5	B	C
22	18.0	36.1	18.1	9.5	9.5	0.0	B	C
23	11.5	41.4	29.9	12.3	10.6	-1.7	B	D
24	0.9	24.9	23.9	15.4	7.1	-8.3	C	A
25	6.1	21.6	15.5	14.7	9.4	-5.3	C	A
26	10.9	27.7	16.7	13.1	8.3	-4.9	C	A
27	9.0	37.9	28.9	13.7	9.1	-4.5	C	A
28	9.5	46.1	36.6	18.4	6.6	-11.9	C	B
29	10.8	27.0	16.2	13.5	11.0	-2.5	C	C
30	7.7	30.3	22.6	13.2	10.1	-3.2	C	C
31	4.0	21.3	17.3	15.4	10.0	-5.4	C	C
32	6.3	28.8	22.5	14.7	10.2	-4.5	C	C
33	8.9	27.9	18.9	15.9	9.8	-6.1	C	C
34	4.3	43.0	38.6	16.0	11.1	-5.0	C	D
35	10.9	40.9	30.0	15.3	10.1	-5.3	C	D
36	9.0	52.9	43.9	14.2	10.5	-3.7	C	D
37	7.7	50.0	42.3	14.2	9.6	-4.7	C	D
38	26.5	65.6	39.2	15.4	8.0	-7.4	D	B
39	20.4	51.4	31.0	15.7	9.3	-6.5	D	B
40	19.5	57.3	37.9	13.1	9.4	-3.7	D	B
41	12.6	35.8	23.2	14.5	10.9	-3.6	D	C
42	13.9	40.7	26.8	17.9	11.3	-6.5	D	C
43	22.1	54.9	32.8	13.1	11.4	-1.6	D	D
44	12.4	55.2	42.8	16.0	9.7	-6.3	D	D
45	14.4	50.1	35.8	15.3	10.8	-4.6	D	D
46	12.2	41.4	29.2	14.8	11.2	-3.6	D	D
Mean	12.8	39.8	27.0	13.2	9.4	-3.8	...	...
Median	11.2	40.8	26.3	13.0	9.5	-3.7	...	...
Semi-interquartile interval	5.2	9.4	5.1	1.5	0.9	1.4	...	...

† Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta
‡ Section A = low revascularization rates and low mortality rates; Section B = high revascularization rates and low mortality rates; Section C = low revascularization rates and high mortality rates; Section D = high revascularization rates and high mortality rates
... not applicable
Source: 1995/1996 and 2003/2004 Health Person-Oriented Information Database.

Although revascularization rates rose in all health regions, those with a low rate in 1995/1996 also tended to have a relatively low rate in 2003/2004. Nonetheless, in both years, rates varied substantially among the regions—from 0.9% to 31.9% in 1995/1996, and from 20.8% to 65.6% in 2003/2004 (Table 1). Even in the same province, variability among health regions was considerable; for example, in one province in 2003/2004, revascularization rates ranged from 22% to 50% (data not shown).

By 2003/2004, 30-day mortality rates among acute myocardial infarction patients had fallen in 42 of the 46 health regions. However, in both years, mortality rates varied widely by region (Table 1), ranging from 7.5% to 18.4% in 1995/1996, and from 5.5% to 12.7% in 2003/2004. Even within the same province, mortality rates varied substantially among health regions; for example, in 2003/2004, in one province, the range was from 5.5% to 11.3% (data not shown).

For both 1995/1996 and 2003/2004, health regions have been classified into four groups (Sections) by comparing their revascularization and mortality rates with the median rates that year. Section A contains regions where both the revascularization and mortality rates were low (below the medians); Section B, regions where the revascularization rate was high (above the median) and the mortality rate was low; Section C, regions where the revascularization rate was low and the mortality rate was high; and Section D, regions where both rates were high.

Despite a tendency for health regions with high revascularization rates to have lower mortality rates, this was not always the case (Table 1). In each year, about 20% of health regions had low revascularization rates and low mortality rates (Section A), and a similar percentage had high revascularization and high mortality rates (Section D). Moreover, during the eight-year period, health regions did not necessarily remain in the same Section—more than half of them were in a different Section in 2003/2004 than they had been in 1995/1996.

The data

The data are from the Health Person-Oriented Information Database, a linkable version of provincial computerized hospital discharge records from the Canadian Institute for Health Information Discharge Abstract Database. These hospital records have been linked to form patient trajectories.

The provinces included in the analysis were Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan and Alberta. Newfoundland and British Columbia were excluded because of anomalous provincial coding practices, and Prince Edward Island was excluded because the province had no revascularization facilities. To ensure a reasonable number of heart attack patients, this study examines only health regions with a population of 100,000 or more—a total of 46.

The analysis focuses on two fiscal years: 1995/1996 (the first year of the Person-Oriented Information Database) and 2003/2004. The year 2003/2004 was the last one for which all provinces involved could be followed up. Patients aged 20 or older were included if they had been admitted to hospital with the most responsible diagnosis being *acute myocardial infarction* (ICD-9-CM code 410; ICD-10-CA codes I21 or I22),[11,12] provided that they had not been hospitalized with acute myocardial infarction in the preceding 365 days. The purpose of the one-year "wash-out" period was to start the analysis with a new episode of acute myocardial infarction. For each patient, two events were examined: whether they received revascularization treatment and whether they died in hospital within 30 days of admission. The latter has been shown to be a good estimate of the total mortality rate.[13]

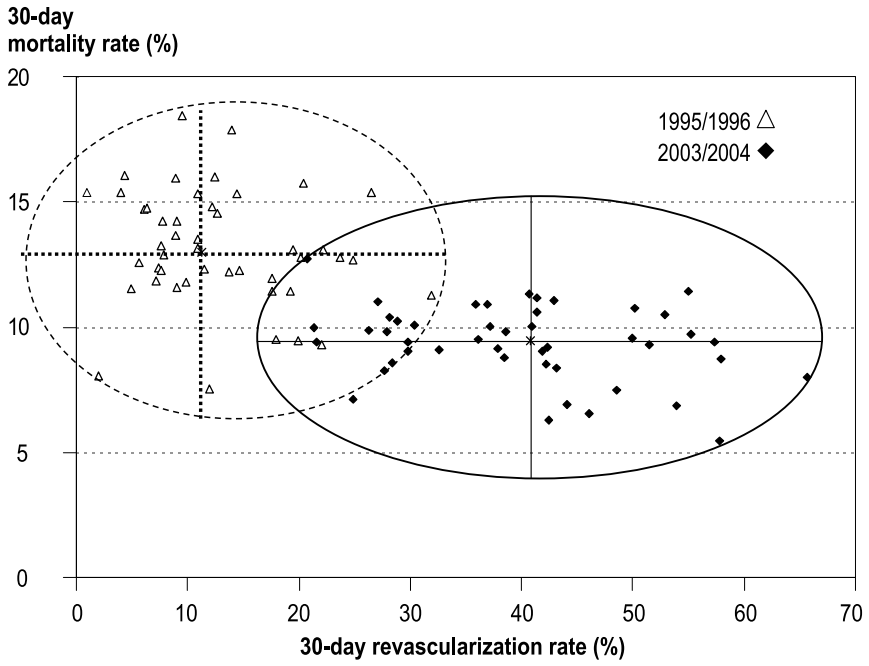
Revascularization procedures were defined with the algorithm described by the Canadian Institute for Health Information as follows: *percutaneous coronary intervention* (ICD-9-CM 36.01, 36.02, 36.05 or ICD-10-Canadian Classification of Interventions 1.IJ.26, 1.IJ.50, 1.IJ.57) and *coronary artery bypass graft surgery* (ICD-9-CM 36.1 or ICD-10-CCI 1.IJ.76).[11,12,14] These procedures are used to treat coronary artery disease, a condition in which fatty deposits accumulate in the cells lining the artery wall and obstruct blood flow. For percutaneous coronary intervention, a large peripheral artery (usually the femoral artery in the leg) is punctured with a needle and a guide wire is threaded through the needle into the arterial system, through the aorta and into the obstructed coronary artery. A catheter with a balloon attached to the tip is threaded over the guide wire and into the obstructed area. The balloon is inflated for several seconds. To keep the artery open, a wire mesh device (stent) may be inserted. Coronary artery bypass graft surgery involves grafting veins (usually from the leg) or arteries (usually from beneath the breastbone) from the aorta to the coronary artery, thus bypassing the obstructed area.

Direct standardization was used for age-sex adjustment. The standard population was acute myocardial infarction patients in the seven provinces in fiscal year 1995/1996, by five-year age group. Only age and sex were used for standardization; previous work has shown that including a co-morbidity index did not substantially change the results.[8]

The Postal Code Conversion file was used to identify Census Dissemination Areas from the patient's residential postal code. Health region (as of 2005) was based on the Census Dissemination Area.

A limitation of the data is that patients cannot be followed across provinces.

Figure 1
30-day revascularization and 30-day mortality rates of acute myocardial infraction patients, health regions with at least 100,000 population, seven provinces,† 1995/1996 and 2003/2004



† Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta
Note: Lines cross at median values of mortality and revascularization within each year.
Source: 1995/1996 and 2003/2004 Health Person-Oriented Information Database.

Revascularization and mortality

Figure 1 brings together and juxtaposes the data on revascularization and mortality rates for each health region to illustrate the association (or lack thereof) between revascularization and mortality among acute myocardial infarction patients. Each point represents a health region: the open triangles pertain to 1995/1996, and the filled diamonds, to 2003/2004. The horizontal axis indicates the percentages of inpatient acute myocardial infarction cases that were treated by revascularization within 30 days; the vertical axis, the percentages who died within 30 days.

The dispersion of values in Figure 1 shows that high revascularization rates were not invariably associated with low mortality rates. For example, in 2003/2004, 11 health regions had high revascularization rates of 50% or more, yet mortality rates in these regions ranged from around 5% to more than 11%. On the other hand, for the same year, in 14 health regions, revascularization rates were relatively low at 30% or less, but mortality rates ranged from 7% to 13%.

Conclusion

Between 1995/1996 and 2003/2004, the overall 30-day revascularization rate among acute myocardial infarction patients in 46 of Canada's largest health regions tripled, and the overall 30-day mortality rate decreased.

In principle, if revascularization was effective and beneficial, higher revascularization rates would be clearly and strongly correlated with lower mortality rates. However, the correlation within a single year was weak at best. In fact, the more recent 2003/2004 data show a weaker correlation between revascularization rates and mortality rates than do the 1995/1996 data. The weaker correlation in 2003/2004 may be due to diminishing returns, as there may be an upper limit to the percentage of patients who would benefit from revascularization.

The large variations in both procedure rates and survival rates across health regions may be associated with factors that could not be considered in the analysis because the relevant data were unavailable. There is clearly much more to treating heart attacks than revascularization. Geographical differences in a surgical procedure rate may reflect systematic variations in professional decision, diagnostic and practice styles, and in physicians' training, experience and beliefs about the efficacy of a procedure. As well, hospital policies, practices and facilities may vary from region to region, as may the severity of heart attack cases. Clinical variables such as arrival time in hospital, use of secondary preventive medications[15,16] and cardiac rehabilitation services[17] may also differ. In addition, lifestyle factors can be important; for example, are heart attack patients in some regions more likely than those in other regions to be smokers, obese or sedentary?

No consensus has emerged in the literature as to what rate of revascularization is optimal for acute myocardial infarction patients. Greater use of the procedure in the United States[18-20] has not consistently been shown to improve mortality rates,[18,19] although one study concluded that American patients survive longer than Canadian patients.[21] As well, randomized trials such as TACTICS, FRISC and CADILLAC have demonstrated benefits of early revascularization,[22-26] and an excess of angina pectoris with resultant diminished quality of life has been reported for the lower Canadian surgery levels for acute myocardial infarction patients, compared with the United States.[19,20]

The results of this analysis suggest that research on the delivery of health

care in Canada might focus on why wide geographical variations persist in the treatment and survival of heart attack patients. More data are required to extend the mortality follow-up beyond 30 days; to determine how much healthier patients are after the procedure; to identify other aspects of treatment and hospital characteristics that might influence the results; and to investigate patient risk factors such as obesity, physical fitness, smoking, hypertension, and blood lipid levels. Knowledge of the factors associated with the geographical differences could aid in the development of guidelines to help clinicians determine if a procedure, in this instance, revascularization, is likely to be beneficial. The analysis needs to be extended to enable us to tell the story of which factors—at the patient, care team, hospital or community level—are most important to health outcomes. ■

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