

# Variations in angioplasty and bypass surgery

Helen Johansen, Cyril Nair and Gregory Taylor

## Abstract

### Objectives

This article describes rates of and times to revascularization procedures for heart attack patients.

### Data source

The data are from Statistics Canada's Person-Oriented Information Data Base. Hospital discharge records for heart attack patients were linked for fiscal years 1992/93 and 1993/94.

### Analytical techniques

Hospital patients admitted between April 1 and September 30, 1993 with a primary diagnosis of acute myocardial infarction (AMI) were followed for six months to determine what percentage underwent percutaneous transluminal coronary angioplasty and/or coronary artery bypass graft surgery. Analyses of time-to-procedure were performed for those patients who had not been hospitalized for AMI in the previous 12 months.

### Main results

Approximately 24,000 Canadians were discharged from hospital during the first half of fiscal year 1993/94 with a diagnosis of AMI. Within six months, 8.7% had an angioplasty and 6.7% had a bypass; overall, 14.9% were revascularized. Women were less likely than men to have a bypass, but angioplasty rates did not differ significantly. The rate of revascularization declined with age. After adjusting for age and sex, rates were higher in the western provinces.

### Key words

myocardial infarction, percutaneous transluminal coronary angioplasty, coronary artery bypass, patient readmission, medical record linkage

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The use of revascularization, a therapeutic approach for coronary heart disease, has increased over the past two decades (see *Cardiac procedures*).<sup>1-3</sup>

Geographic variations in revascularization rates within Canadian provinces<sup>4-7</sup> and between Canada and the United States<sup>8-10</sup> have sparked debate on the appropriate rate of use of these procedures and raised questions about waiting times.<sup>11-15</sup>

This article uses Statistics Canada's Person-Oriented Information Data Base to examine rates of revascularization—percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass graft (CABG) surgery—among people who were admitted to hospital with a heart attack (acute myocardial infarction or AMI) from April 1 to September 30, 1993. Hospital records for these patients for the succeeding six months were analysed to calculate revascularization rates by age, sex and province (see *Methods* and *Limitations*). Time-to-procedure was calculated for patients who had not been hospitalized for an earlier heart attack during the previous 12 months.

## Methods

### Data source

Hospital morbidity files are provided annually to Statistics Canada by the provinces and territories. Each record contains information abstracted from a patient's hospital chart and pertains to one hospital separation. The data in this analysis are from the Person-Oriented Information Data Base. Hospital records for each province (data for the territories were excluded) for the fiscal years 1992/93 and 1993/94 were linked using patient identification numbers. (Patient names are not provided to Statistics Canada.)

### Analytical techniques

Hospital patients often receive several diagnoses. Of these, the one accounting for the longest length of stay is known as the "tabulation diagnosis." The tabulation diagnosis is usually the same as the primary diagnosis—the condition responsible for the hospital stay. In this article, the term "primary diagnosis" is used for tabulation diagnosis.

For this analysis, a heart attack patient was defined as someone who had one or more hospital stays for acute myocardial infarction (AMI) during the year. Individuals with AMI who died in hospital are included.<sup>7,10,16</sup> The diagnosis for AMI in the International Classification of Diseases, Ninth Revision (ICD-9)<sup>17</sup>—410—was used to identify heart attack patients.

The first primary diagnosis of heart attack in the period between April 1 and September 30, 1993 was considered the "index event." The use of an index event measures the elapsed time from heart attack to revascularization and does not depend on referral time for angiography. Information on cardiac procedures and deaths in hospital (deaths occurring outside hospital were not included) was obtained for each of these heart attack patients for the six months after their index event.

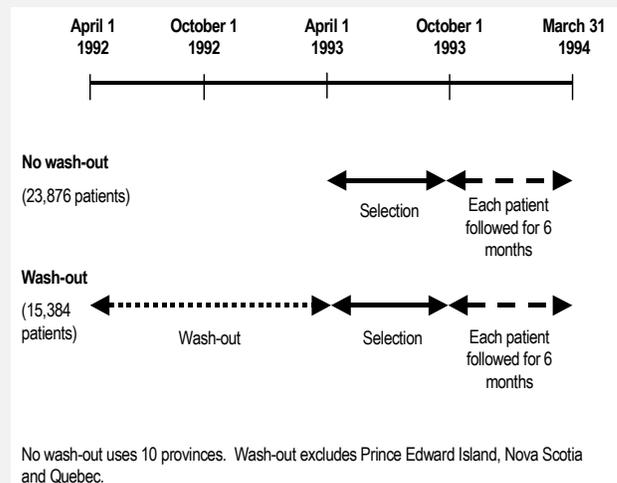
All patients were followed for six months to determine if they underwent percutaneous transluminal coronary angioplasty (PTCA) and/or coronary artery bypass graft (CABG) surgery (see *Cardiac procedures*). The Canadian Classification of Procedures (CCP)<sup>18</sup> was used to identify CABG (48.11-48.19) and PTCA (48.00-48.08, 51.59).<sup>7</sup>

The inclusion of patients admitted to hospital for tests to rule out a diagnosis of heart attack can artificially inflate the numbers. To reduce false-positive diagnoses, patients discharged alive within four days and who did not have a PTCA were excluded from this analysis.<sup>7,10,16</sup>

A variety of methods might be used to calculate time-to-procedure.<sup>19</sup> For this analysis, time-to-procedure was estimated by subtracting the admission date of the first hospital stay during which the revascularization procedure was done from the admission date of the index visit, as this includes variations in the time to see a specialist and be placed on a waiting list. If the procedure occurred during the index visit, time-to-procedure was considered half the length of stay. This arbitrary cut-off was necessary because some jurisdictions

report the date when each procedure was performed, but others do not.

Calculations of time-to-procedure are based on patients who had a heart attack in the first half of fiscal year 1993/94 and who had not been hospitalized for heart attack in the preceding 12 months. They are referred to as having a 12-month "wash-out" period. This restriction was necessary for calculations of time-to-procedure. Without the wash-out period, the index event would not have been identified. This is because patients who had had a heart attack in the previous year might have been waiting for revascularization when they had the attack that caused their admission to hospital in the six months from April 1 to September 30, 1993. The second heart attack may have increased their priority on the waiting list, so that a relatively short time would elapse until they had an angioplasty or bypass. However, their actual time-to-procedure would not be recorded.



Wash-out periods could not be applied to Quebec and Nova Scotia data because those provinces scrambled the patient identifiers differently each year. As well, all revascularizations of Prince Edward Island residents were performed out of province and were not captured. Consequently, the analysis of time-to-procedure excludes Prince Edward Island, Nova Scotia and Quebec.

To determine the extent to which exclusion of these provinces affects the results, data for the other provinces were compared with those for all patients who suffered a heart attack in the first half of fiscal year 1993/94. Calculations based on these provinces (Appendix Tables A to E) were similar to those based on all 10 provinces.

Logistic regression was used to adjust provincial rates for age and sex. The median time-to-procedure was tested by the Wilcoxon test for the comparison of men and women, and by the Kruskal-Wallis test for the comparison of age and province.<sup>20</sup> Age comparisons were done starting from age 35.

This analysis is intended to provide empirical data on revascularization rates and waiting times for heart attack patients in Canada. It does not indicate whether rates are too low or too high, or whether time-to-procedure is too long or too short.

### Few undergo revascularization

During the first half of fiscal year 1993/94, 23,876 Canadians were discharged from hospital with a primary diagnosis of heart attack (Table 1). Almost two-thirds of these patients were men, and one-third were aged 75 or older.

In the six months after their heart attack, 8.7% of patients underwent percutaneous transluminal coronary angioplasty, and 6.7% had coronary artery bypass graft surgery (Table 2). The total revascularized was 14.9%, slightly less than the sum of those who had an angioplasty and those who had bypass surgery, indicating that some patients had both procedures within the six months.<sup>21,22</sup> Rates calculated for the seven provinces for which a 12-month wash-out period could be determined (that is, they had not been hospitalized for a heart attack, ICD-9 410, in the preceding year) show that of the 2,170 patients who underwent revascularization, 47.3% had one angioplasty, 43.4% had bypass surgery, 6.4% had more than one angioplasty, and 2.9% had both procedures.

Table 1  
Number of heart attack patients hospitalized between April 1 and September 30, 1993, by sex and province, Canada excluding territories

|                      | Total  | Men    | Women |
|----------------------|--------|--------|-------|
| <b>All provinces</b> | 23,876 | 15,218 | 8,658 |
| Newfoundland         | 635    | 384    | 251   |
| Prince Edward Island | 110    | 71     | 39    |
| Nova Scotia          | 713    | 455    | 258   |
| New Brunswick        | 819    | 524    | 295   |
| Quebec               | 6,362  | 4,138  | 2,224 |
| Ontario              | 9,528  | 5,967  | 3,561 |
| Manitoba             | 885    | 546    | 339   |
| Saskatchewan         | 893    | 579    | 314   |
| Alberta              | 1,638  | 1,072  | 566   |
| British Columbia     | 2,293  | 1,482  | 811   |

Data source: Person-Oriented Information Data Base

### Procedures vary with age and sex

The revascularization procedures performed on heart attack patients varied with their age and sex. At ages up to 60, angioplasty was generally more common. Among older patients, bypasses were performed as often as, and sometimes more frequently than, angioplasties (Chart 1).

#### Cardiac procedures

Coronary artery disease is a condition in which fatty deposits accumulate in the cells lining the wall of a coronary artery and obstruct blood flow.<sup>23</sup> Angina, which often results from coronary artery disease, is temporary chest pain or a sensation of pressure that occurs while heart muscle is not receiving enough oxygen. Coronary artery bypass graft (CABG) surgery and percutaneous transluminal coronary angioplasty (PTCA) are revascularization methods that improve the flow of blood to the heart.

Bypass 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.<sup>23</sup> Bypass surgery is highly effective in people who have angina and coronary heart disease that is not widespread. It can improve exercise tolerance, reduce symptoms, and decrease the number or dose of drugs needed. Those most likely to have bypass surgery are persons with: severe angina that has not improved with drug therapy; a normally functioning heart; no previous heart attacks; and no other conditions that would make surgery hazardous.<sup>23</sup>

For angioplasty, a large peripheral artery (usually the femoral artery in the leg) is punctured with a needle.<sup>23</sup> 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 diseased coronary artery to the obstructed area. The balloon is inflated for several seconds. It may be inflated and deflated several times, thereby reducing the obstruction.

The number of revascularizations performed in Canada is rising. From 1990/91 to 1995/96, the annual number of bypasses increased 37% from 13,500 to 18,500. At the same time, angioplasties rose 47% from 16,100 to 23,600. Because the risks associated with surgery are higher for people with damaged heart muscle from a previous heart attack, AMI patients accounted for only a small fraction of these bypasses and angioplasties. However, revascularization may be performed on heart attack patients for whom other therapies are not effective. While the risk is greater among patients with severe disease, the benefits may also be greater.

Table 2

Percentage of heart attack patients hospitalized between April 1 and September 30, 1993 who had revascularization procedure within six months, by sex and province, Canada excluding territories

|                      | Percutaneous transluminal coronary angioplasty (PTCA) |      |       | Coronary artery bypass graft surgery (CABG) |      |       | At least one revascularization procedure† |      |       |
|----------------------|---|------|-------|---|------|-------|---|------|-------|
|                      | Total   | Men  | Women | Total                                       | Men  | Women | Total                                     | Men  | Women |
|                      | %   |      |       | %   |      |       | %   |      |       |
| <b>Total</b>         | 8.7   | 9.8  | 7.0   | 6.7   | 7.9  | 4.5   | 14.9                                      | 17.1 | 11.2  |
| Newfoundland         | 3.8   | 3.6  | 4.0   | 5.4   | 5.2  | 5.6   | 9.1                                       | 8.9  | 9.6   |
| Prince Edward Island | ...   | ...  | ...   | ...   | ...  | ...   | ...                                       | ...  | ...   |
| Nova Scotia          | 7.0   | 7.0  | 7.0   | 7.6   | 9.2  | 4.7   | 14.2                                      | 15.8 | 11.2  |
| New Brunswick        | 8.4   | 10.3 | 5.1   | 5.7   | 6.9  | 3.7   | 13.8                                      | 16.6 | 8.8   |
| Quebec               | 11.0  | 12.4 | 8.5   | 6.7   | 7.9  | 4.5   | 17.1                                      | 19.5 | 12.7  |
| Ontario              | 5.8   | 6.5  | 4.8   | 6.4   | 7.8  | 4.2   | 11.8                                      | 13.6 | 8.7   |
| Manitoba             | 6.2   | 7.5  | 4.1   | 5.2   | 5.9  | 4.1   | 11.4                                      | 13.4 | 8.3   |
| Saskatchewan         | 9.7   | 10.7 | 8.0   | 5.9   | 7.4  | 3.2   | 15.6                                      | 18.0 | 11.2  |
| Alberta              | 17.7  | 18.1 | 17.0  | 8.5   | 10.3 | 5.1   | 25.9                                      | 28.2 | 21.7  |
| British Columbia     | 11.1  | 13.0 | 7.6   | 7.8   | 8.4  | 6.7   | 18.2                                      | 20.8 | 13.6  |

**Data source:** Person-Oriented Information Data Base

† May be less than the sum of those with PTCA and CABG, as some patients had both.

... Not applicable

## Limitations

In the Person-Oriented Information Data Base, record linkage was conducted separately for each province. Thus, a patient with heart attack-related hospital admissions in two different provinces during the same fiscal year would be counted more than once. However, the effect of these events on the overall results is considered small. In fact, because procedures performed outside a patient's province of residence are not always counted, it is more likely that out-of-province procedures could result in an underestimation of the number of residents of a particular province undergoing follow-up surgery. When all bypasses, not just those on heart attack patients, are considered, 279 were performed on non-residents of the province where the surgery took place. Of these, 119 were captured in their province of residence. Of 256 angioplasties performed on non-residents, just 64 were coded in the patients' province of residence.

Six months after patients suffered a heart attack, the time-to-bypass had not reached a plateau, indicating that the six-month period during which patients were tracked is too short to indicate the percentage who eventually undergo the procedure. However, because of constraints in the Person-Oriented Data Base, it was not possible to follow patients for a longer time. Comparisons with other studies of time-to-procedure should take account of the relatively limited period on which this analysis is based.

The deaths reported in this article pertain only to those that occurred in hospitals. AMI patients who died out of hospital

(according to vital statistics data, approximately 69% of male AMI deaths and 60% of female AMI deaths<sup>24</sup>) are not included.

A major limitation of this analysis is the lack of data on risk factors, disease severity, medications and specific treatments, and follow-up information on functional status, morbidity and mortality. Ideally, to assess treatments and do epidemiological research, pre-infarction and post-discharge data would be linked to hospital registry data. Linking clinical data to information available in vital statistics and hospital discharge records would provide longer term follow-up without the need for costly direct data collection from the patients.<sup>25</sup>

Tracking an inception cohort of patients, all of whom have had a heart attack (ICD-9 410), reduces but does not completely eliminate geographic variations in disease severity.<sup>7</sup> Results based on co-morbidity as a measure of severity suggest that the average severity of heart attacks varies considerably across provinces.<sup>26</sup>

Provincial differences in coding practices may affect the data. There are up to 12 procedure fields per hospital record. Different provinces record a different number of procedures for each hospital visit.

The validity and reliability of hospital discharge data may have an effect on the results. Some studies have found AMI hospital-discharge diagnoses to be good.<sup>25,27</sup> However, another report<sup>28</sup> found that the reliability of hospital discharge register data should be regularly assessed. Two Canadian studies found false positive rates of 8% to 21%, but they included patients among whom AMI was later ruled out.<sup>29,30</sup>

Men were generally more likely than women to have undergone revascularization: 17% versus 11%. The difference was more pronounced for bypasses (7.9% compared with 4.5%) than for angioplasties (9.8% compared with 7.0%). Other research, too, has shown female heart attack patients to be less likely than male patients to have invasive cardiac procedures.<sup>31,32</sup> An Ontario study<sup>16</sup> found rates of coronary angiography and bypass surgery to be significantly lower among women than men. In the United States, sex differences remained even after matching for the hospital of admission and controlling for other factors that influence procedure rates.<sup>33</sup>

For men, angioplasty rates were highest at ages 35 to 44, whereas bypass surgery peaked among those in their late fifties. For female patients, angioplasty rates peaked at ages 45 to 49 and dropped steadily from ages 55 to 59 onwards. By contrast, with the exception of women aged 55 to 59 whose rate was very low, there was relatively little difference by age in the percentage of female patients who underwent bypass surgery until they reached their seventies.

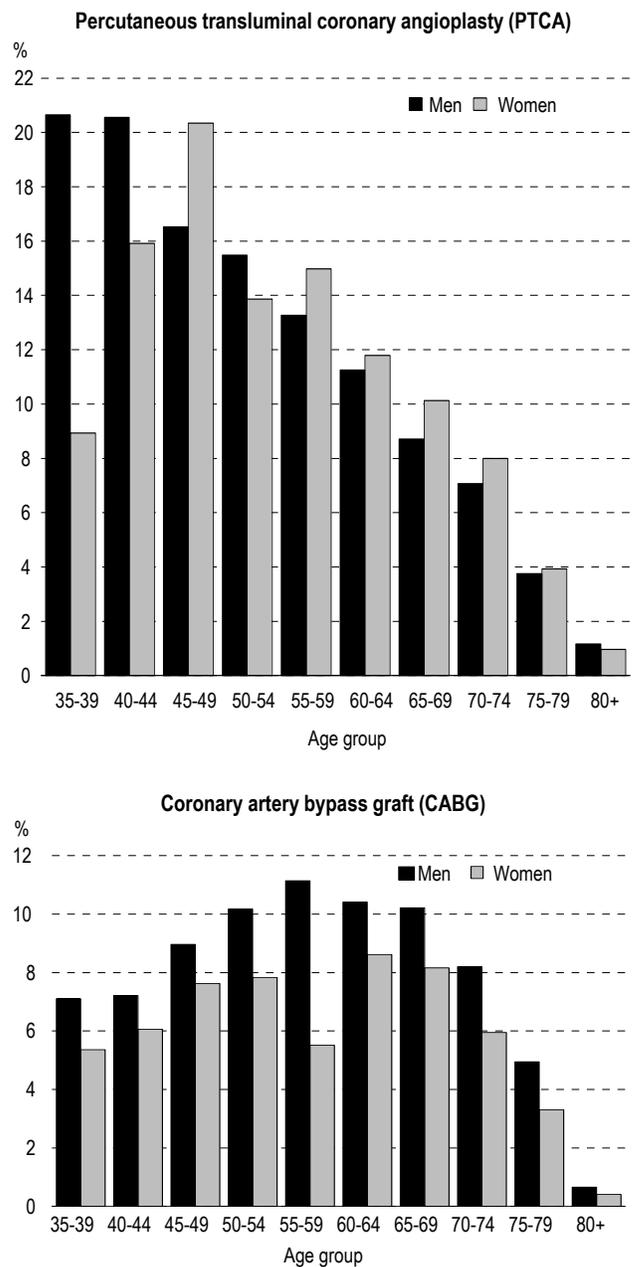
After age 55, female heart attack patients were more likely than their male counterparts to have an angioplasty. However, at all ages, a higher percentage of male than female patients had bypass surgery.

Rates for both procedures declined sharply among male and female patients after age 70. The management of ischemic heart disease in the elderly is complex. Invasive revascularization therapies are associated with high morbidity and mortality.<sup>34</sup> As well, the elderly are more likely to have complications that contraindicate such procedures. It is not surprising, then, that fewer than 4% of hospitalized heart attack patients older than 74 had a revascularization procedure. However, a higher death rate at older ages helps explain this low percentage.

To some degree, the lower revascularization rate among women compared with men might be influenced by women's longer life expectancy. This results in a higher proportion of women in the oldest age groups, who are the least likely to undergo revascularization. Yet when age and province were

taken into account, men's odds of having a bypass were one and a half times the odds for women. For angioplasties, however, there was no significant difference (Table 3).

Chart 1  
**Percentage of heart attack patients hospitalized between April 1 and September 30, 1993 who had revascularization within six months, by age, sex and procedure, Canada excluding territories**



Data source: Person-Oriented Information Data Base

Table 3  
Odds ratios relating revascularization procedures to age, sex and province, heart attack patients hospitalized between April 1 and September 30, 1993, Canada, nine provinces

|                           | Percutaneous transluminal coronary angioplasty (PTCA) |                         | Coronary artery bypass graft (CABG) |                         | At least one revascularization procedure |                         |
|---------------------------|---|-------------------------|-------------------------------------|-------------------------|--|-------------------------|
|                           | Odds ratio  | 95% confidence interval | Odds ratio                          | 95% confidence interval | Odds ratio                               | 95% confidence interval |
| <b>Sex</b>                |   |                         |                                     |                         |  |                         |
| Men                       | 1.0   | 0.9, 1.1                | 1.5*                                | 1.3, 1.7                | 1.2*                                     | 1.1, 1.3                |
| Women†                    | 1.0   | ...                     | 1.0                                 | ...                     | 1.0                                      | ...                     |
| <b>5-year age groups‡</b> | 0.8*  | 0.8, 0.8                | 0.9*                                | 0.9, 0.9                | 0.8*                                     | 0.8, 0.8                |
| <b>Provinces§</b>         |   |                         |                                     |                         |  |                         |
| Newfoundland              | 0.5*  | 0.3, 0.8                | 0.8                                 | 0.6, 1.2                | 0.7*                                     | 0.5, 0.9                |
| Nova Scotia               | 1.1   | 0.8, 1.5                | 1.1                                 | 0.8, 1.5                | 1.1                                      | 0.9, 1.4                |
| New Brunswick             | 1.5*  | 1.1, 2.0                | 0.9                                 | 0.6, 1.2                | 1.2*                                     | 1.0, 1.5                |
| Quebec                    | 1.9*  | 1.7, 2.1                | 1.0                                 | 0.8, 1.1                | 1.4*                                     | 1.3, 1.6                |
| Ontario†                  | 1.0   | ...                     | 1.0                                 | ...                     | 1.0                                      | ...                     |
| Manitoba                  | 1.2   | 0.9, 1.6                | 0.9                                 | 0.6, 1.2                | 1.1                                      | 0.9, 1.3                |
| Saskatchewan              | 2.1*  | 1.6, 2.7                | 0.9                                 | 0.6, 1.2                | 1.5*                                     | 1.2, 1.9                |
| Alberta                   | 3.6*  | 3.0, 4.2                | 1.3*                                | 1.1, 1.6                | 2.7*                                     | 2.4, 3.1                |
| British Columbia          | 2.2*  | 1.8, 2.6                | 1.3*                                | 1.1, 1.5                | 1.8*                                     | 1.6, 2.1                |

Data source: Person-Oriented Information Data Base

Note: The analyses were based on 23,766 cases.

† Reference category, for which odds ratio is always 1.0

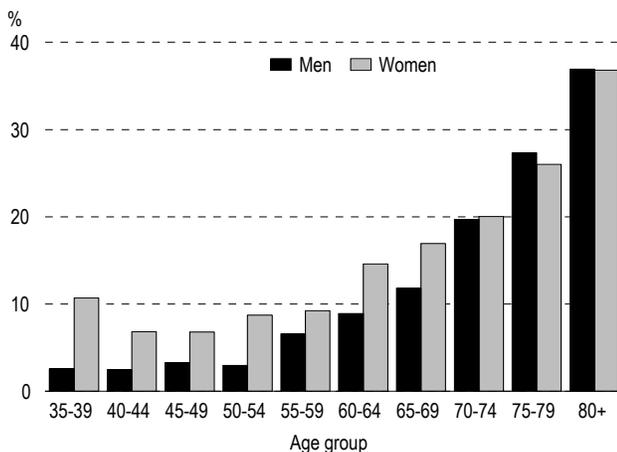
‡ Coded from low to high

§ Excludes Prince Edward Island

... Not applicable

\*  $p < 0.05$

Chart 2  
Percentage of heart attack patients hospitalized between April 1 and September 30, 1993 who died in hospital† within six months, by age and sex, Canada excluding territories



Data source: Person-Oriented Information Data Base

† Out-of-hospital deaths not included

Overall, 18% of heart attack patients died in hospital within six months of having suffered the attack: 15% of the men and 23% of the women. (Of those who underwent revascularization, 3.7% died in hospital: 3.4% of the men and 4.5% of the women.) These high death rates largely reflect the situation at older ages. A third of heart attack patients aged 75 and older died in hospital within the first six months, most of them within the first two weeks.

Female heart attack patients had higher in-hospital death rates than did male patients before age 70; at older ages, rates were almost the same for men and women (Chart 2). The few (56) women aged 35 to 39 who had a heart attack had a relatively high death rate, higher than that of women twenty years older.

### Rates higher in west

In 1993/94, revascularization rates varied substantially by province, with rates generally higher in the west (Table 2). The percentage of heart attack patients undergoing revascularization ranged from 9.1% in Newfoundland to 25.9% in Alberta. Alberta had the highest rates for both procedures: 17.7% of patients had an angioplasty and 8.5% had a bypass within six months of their heart attack. Newfoundland had the lowest angioplasty rate (3.8%); Manitoba, the lowest bypass rate (5.2%). Except for Newfoundland, rates for both procedures in each province were higher for men than women.

When age and sex were taken into account, the odds of undergoing angioplasty were significantly high for heart attack patients in New Brunswick, Quebec, Saskatchewan, Alberta, and British Columbia, compared with the odds for patients in Ontario; the odds were significantly low for Newfoundland patients (Table 3). The odds of bypass surgery were significantly high only for patients in Alberta and British Columbia.

The data on which this analysis is based do not suggest an explanation for the provincial differences in revascularization rates. Data are reported for both angioplasties and bypasses, so the differences are not attributable to provincial preferences for one procedure over the other. Earlier studies have shown

no evidence of inappropriate use of procedures.<sup>35,36</sup> Economic considerations are important, but would be a factor in all provinces. The availability of facilities may play a role, particularly in Atlantic Canada, where patients may go out of province for a procedure, and are therefore not captured on this database. Geographic variations in disease rates were reduced by tracking an inception cohort of heart attack patients. Because all the patients had an acute coronary event, geographic differences in disease severity were minimized, but by no means completely eliminated.<sup>7</sup> A recent study has suggested that the average severity of heart attacks varies considerably across provinces.<sup>26</sup>

### Time-to-procedure

In order to start from a new episode of heart disease and not artificially shorten waiting periods, median time-to-procedure was calculated for patients who had not been admitted to hospital for heart attack in the previous year (a 12-month “wash-out” period). These calculations could be made for seven provinces and exclude Quebec, Nova Scotia and Prince Edward Island.

The median time-to-procedure for an angioplasty was 11 days, and for a bypass, 44.5 days (Table 4). Time-to-procedure did not vary substantially by the age of the patient, although younger men tended to wait longer for a bypass than did older men. Women did not wait as long as men for a bypass (30 versus 49 days). Since waiting lists are structured to give priority to patients with the greatest need, this is consistent with women typically having more severe heart disease.<sup>37</sup>

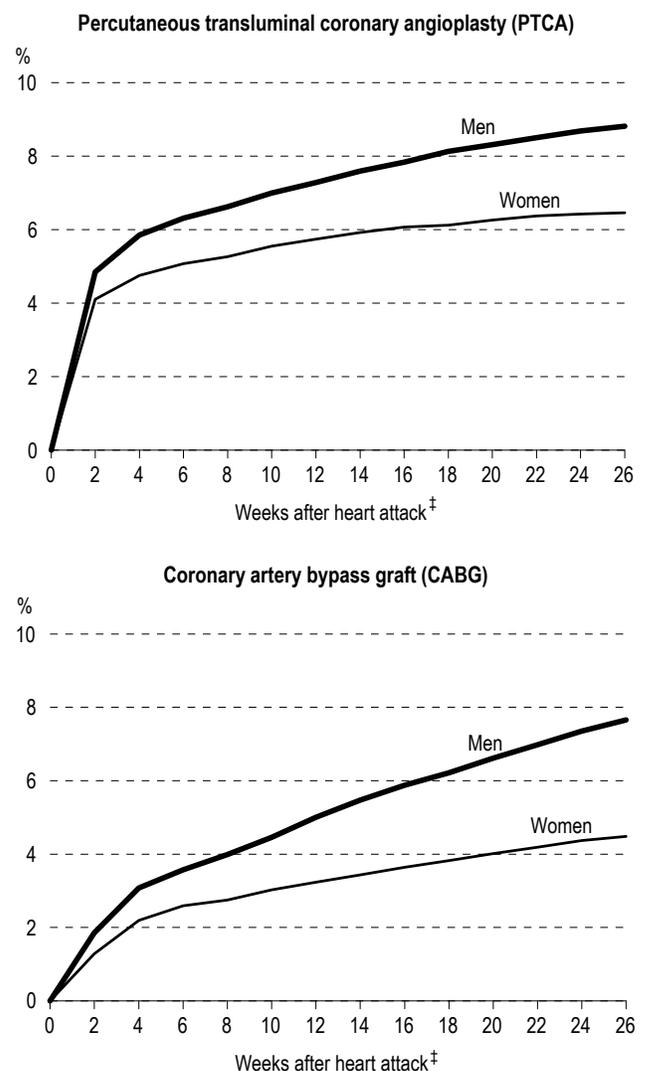
Time-to-procedure for an angioplasty differed substantially by province. For men, the median time ranged from 7 days in Manitoba and Alberta to 24 days in Newfoundland. For women, the range was from 7 days in Alberta to 18 days in Newfoundland. These provincial differences were statistically significant.

Time-to-procedure for a bypass also varied from one province to another, although these differences were not statistically significant. For men, the shortest median times were in Newfoundland and Manitoba (fewer than 28 days), while the longest

was in Ontario (57 days). Women’s medians ranged from 11 days in New Brunswick to 37 days in British Columbia.

As the relative times-to-procedure indicate, angioplasties tend to be performed much sooner after a heart attack than bypasses. For both men and women, the cumulative rates of angioplasty rose sharply and then levelled off. But even after six

Chart 3  
**Cumulative rate of revascularization among heart attack patients hospitalized between April 1 and September 30, 1993, based on a 12-month wash-out period, by sex, Canada, seven provinces†**



Data source: Person-Oriented Information Data Base  
 † Excludes Prince Edward Island, Nova Scotia and Quebec.  
 ‡ First primary diagnosis of acute myocardial infarction

Table 4

Median time-to-procedure for heart attack patients hospitalized between April 1 and September 30, 1993 who had revascularization within 6 months, by age, sex and province, based on a 12-month wash-out period, Canada, seven provinces

|  | Percutaneous transluminal coronary angioplasty (PTCA) |        |                      | Coronary artery bypass graft (CABG) |        |                      | At least one revascularization procedure |        |                      |
|--|---|--------|----------------------|-------------------------------------|--------|----------------------|--|--------|----------------------|
|  | Number of patients                                    | Median | Inter-quartile range | Number of patients                  | Median | Inter-quartile range | Number of patients <sup>†</sup>          | Median | Inter-quartile range |
|  | Days  |        |                      | Days                                |        |                      | Days                                     |        |                      |
| <b>Seven provinces<sup>‡</sup></b>     | 1,228   | 11.0   | 5.5-48.0             | 1,004                               | 44.5   | 14.0-105.5           | 2,170                                    | 19.0   | 7.0-79.0             |
| <b>Sex</b>                             |   |        |                      |                                     |        |                      |  |        |                      |
| Men                                    | 865   | 12.0   | 5.5-57.0             | 753                                 | 49.0   | 15.0-109.0           | 1,572                                    | 22.0   | 8.0-84.0             |
| Women                                  | 363   | 9.5    | 5.5-33.0             | 251                                 | 30.0   | 12.5-94.0            | 598                                      | 15.0   | 7.0-62.0             |
| <i>Significance level<sup>§</sup></i>  |   |        | 0.0683               |                                     |        | 0.0070               |  |        | 0.0002               |
| <b>Sex and age</b>                     |   |        |                      |                                     |        |                      |  |        |                      |
| <b>Men</b>                             |   |        |                      |                                     |        |                      |  |        |                      |
| 20-34                                  | 13  | 7.0    | 3.5-21.0             | 2                                   | 139.0  | 98.0-180.0           | 15                                       | 12.0   | 3.5-98.0             |
| 35-49                                  | 194   | 15.0   | 5.0-70.0             | 110                                 | 65.0   | 19.0-133.0           | 297                                      | 30.0   | 7.0-91.0             |
| 50-64                                  | 398   | 11.5   | 5.5-60.0             | 339                                 | 58.0   | 16.0-114.0           | 712                                      | 23.0   | 7.5-87.0             |
| 65-79                                  | 244   | 10.0   | 6.0-35.0             | 294                                 | 37.5   | 14.0-93.0            | 526                                      | 20.0   | 8.0-74.0             |
| 80+                                    | 16  | 13.5   | 4.0-20.5             | 8                                   | 31.8   | 15.0-70.0            | 22                                       | 15.3   | 5.5-31.0             |
| <i>Significance level<sup>††</sup></i> |   |        | 0.2769               |                                     |        | 0.071                |  |        | 0.3505               |
| <b>Women</b>                           |   |        |                      |                                     |        |                      |  |        |                      |
| 20-34                                  | 2   | 24.0   | 3.0-45.0             | 3                                   | 89.0   | 6.0-164.0            | 5  | 45.0   | 6.0-89.0             |
| 35-49                                  | 45  | 10.5   | 5.0-29.0             | 22                                  | 29.0   | 10.5-68.0            | 63                                       | 14.0   | 6.0-44.0             |
| 50-64                                  | 123   | 9.5    | 5.0-24.0             | 74                                  | 31.5   | 14.0-107.0           | 193                                      | 14.0   | 6.0-59.0             |
| 65-79                                  | 174   | 9.0    | 5.5-33.0             | 146                                 | 29.0   | 12.0-94.0            | 312                                      | 16.0   | 7.5-69.0             |
| 80+                                    | 18  | 12.0   | 6.5-26.0             | 6                                   | 22.0   | 12.5-31.0            | 24                                       | 13.3   | 9.0-30.5             |
| <i>Significance level<sup>††</sup></i> |   |        | 0.7315               |                                     |        | 0.732                |  |        | 0.5289               |
| <b>Sex and province</b>                |   |        |                      |                                     |        |                      |  |        |                      |
| <b>Men</b>                             |   |        |                      |                                     |        |                      |  |        |                      |
| Newfoundland                           | 11  | 24.0   | 7.0-34.0             | 19                                  | 23.0   | 12.0-133.0           | 30                                       | 23.5   | 9.5-72.0             |
| New Brunswick                          | 51  | 20.0   | 6.0-75.0             | 30                                  | 54.5   | 11.0-141.0           | 78                                       | 24.5   | 8.0-93.0             |
| Ontario                                | 364   | 16.0   | 6.0-77.0             | 435                                 | 57.0   | 17.0-114.0           | 765                                      | 30.0   | 9.5-98.0             |
| Manitoba                               | 38  | 6.75   | 5.0-18.0             | 26                                  | 27.5   | 9.0-78.0             | 64                                       | 10.5   | 5.75-39.5            |
| Saskatchewan                           | 58  | 18.3   | 5.5-67.0             | 33                                  | 41.0   | 18.0-86.0            | 90                                       | 25.8   | 7.0-75.0             |
| Alberta                                | 180   | 7.0    | 5.0-19.5             | 98                                  | 50.0   | 17.0-97.0            | 277                                      | 13.0   | 6.0-61.0             |
| British Columbia                       | 163   | 11.0   | 5.5-41.0             | 112                                 | 40.5   | 12.0-95.5            | 268                                      | 16.5   | 7.0-72.5             |
| <i>Significance level<sup>††</sup></i> |   |        | 0.0001               |                                     |        | 0.256                |  |        | 0.0001               |
| <b>Women</b>                           |   |        |                      |                                     |        |                      |  |        |                      |
| Newfoundland                           | 8   | 18.0   | 5.5-25.5             | 12                                  | 29.0   | 13.5-59.5            | 20                                       | 24.0   | 8.5-40.5             |
| New Brunswick                          | 15  | 9.0    | 5.5-60.0             | 11                                  | 11.0   | 6.0-109.0            | 26                                       | 9.5    | 6.0-60.0             |
| Ontario                                | 160   | 11.0   | 6.3-45.0             | 134                                 | 30.0   | 14.0-104.0           | 284                                      | 19.0   | 8.5-74.5             |
| Manitoba                               | 12  | 8.5    | 7.0-84.5             | 13                                  | 18.0   | 7.0-77.0             | 25                                       | 12.0   | 7.0-79.0             |
| Saskatchewan                           | 24  | 11.0   | 5.0-43.0             | 9                                   | 28.0   | 15.5-71.0            | 33                                       | 17.0   | 8.0-55.0             |
| Alberta                                | 89  | 7.0    | 5.0-13.0             | 25                                  | 22.0   | 13.5-71.0            | 113                                      | 9.0    | 5.5-16.0             |
| British Columbia                       | 55  | 11.0   | 5.0-51.0             | 47                                  | 37.0   | 12.0-94.0            | 97                                       | 18.0   | 7.5-68.0             |
| <i>Significance level<sup>††</sup></i> |   |        | 0.0131               |                                     |        | 0.572                |  |        | 0.0001               |

**Data source:** Person-Oriented Information Data Base

**Note:** Age comparisons were done starting from age 35.

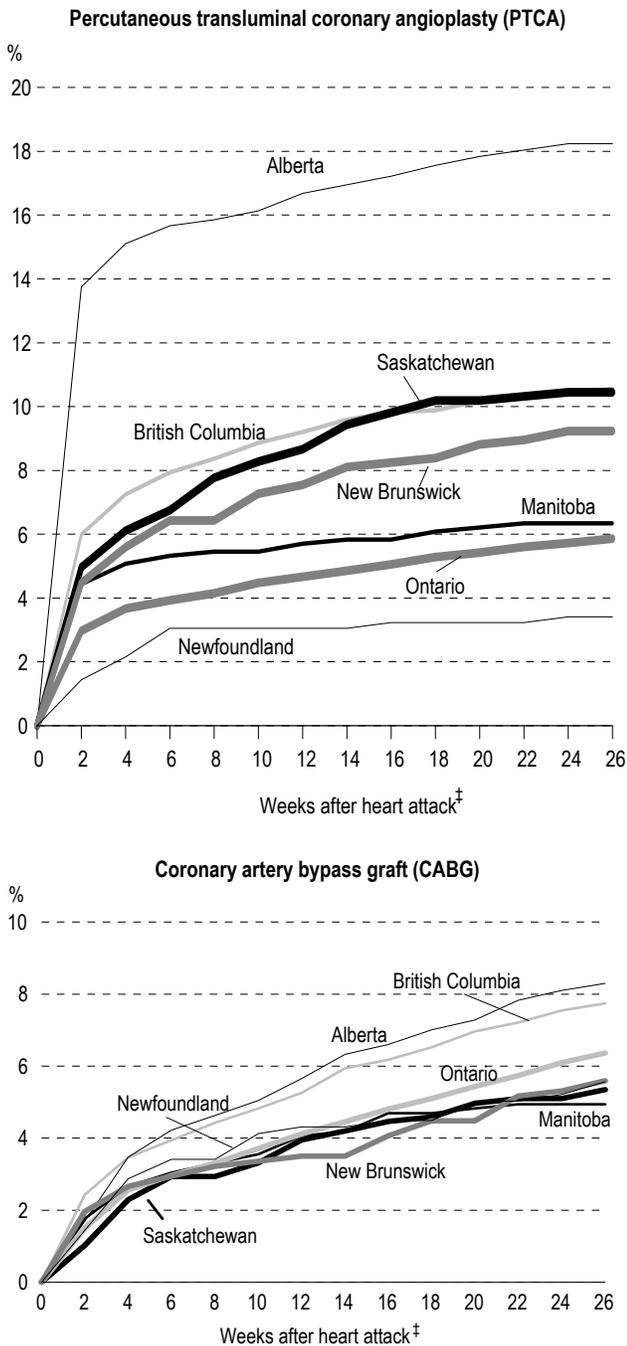
<sup>†</sup> May be less than the sum of those with PTCA and CABG, as some patients had both.

<sup>‡</sup> Excludes Prince Edward Island, Nova Scotia and Quebec.

<sup>§</sup> Wilcoxon test

<sup>††</sup> Kruskal-Wallis test

**Chart 4**  
**Cumulative rate of revascularization among heart attack patients hospitalized between April 1 and September 30, 1993, based on a 12-month wash-out period, Canada, seven provinces†**



**Data source:** Person-Oriented Information Data Base  
 † Excludes Prince Edward Island, Nova Scotia and Quebec.  
 ‡ First primary diagnosis of acute myocardial infarction

months, bypass rates had not levelled off and could well continue to climb (Chart 3). As a result, the ultimate median time-to-bypass will be much longer than the medians calculated here, which cover only a six-month period. Cumulative rates also show strong provincial variations, particularly for angioplasties (Chart 4). Angioplasty rates in Alberta heart attack patients rose sharply and remained much higher than in the other provinces throughout the six months. Alberta's cumulative rate for bypasses also exceeded that of the other provinces, but the difference was less pronounced.

**Concluding remarks**

There is no consensus on the optimal rate of revascularization after a heart attack. Studies conducted in North America and Europe have reported revascularization rates ranging from 3%<sup>38</sup> to 15%.<sup>39</sup> As well, much less revascularization is performed in Canada than in the United States,<sup>8,9</sup> particularly among the elderly.<sup>10,36</sup>

The greater use of revascularization in the United States has not been shown to improve mortality rates.<sup>8,9</sup> However, better survival rates have been found for prompt revascularization, compared with drug therapy.<sup>40,41</sup> As well, a significant excess of angina pectoris with resultant diminishing of quality of life has been reported for the lower Canadian surgery levels, compared with those in the United States.<sup>8,9</sup> Yet while overall revascularization rates may be lower in Canada, Canada's universal health insurance system reduces the influence of income on access to bypass surgery that prevails in the United States.<sup>42</sup>

International differences in waiting times for cardiac procedures are also considerable. Patients treated in Canada wait significantly longer than do those in the United States.<sup>36,43</sup>

To treat patients with more severe disease first, scales have been developed to rank them on waiting lists.<sup>44-46</sup> Of course, priority scores are less than perfect assessments of the time that can safely elapse before readmission to hospital.<sup>15</sup> A patient on a waiting list can experience an adverse event much earlier than might have been predicted.<sup>47</sup> Although long waiting times do not seem to affect the success

rate of revascularizations (except in patients with total coronary occlusions<sup>48,49</sup>), quality of life can be compromised, as patients may be anxious and fearful.<sup>7,14,50,51</sup> For instance, among patients on the waiting list for bypasses in Ontario from October 1991 to July 1993, symptoms provoked by very modest exertion were common.<sup>11</sup> Another report found that 30% of patients on waiting lists needed heart-related sick leave, 32% had lost income, and 20% claimed financial hardship.<sup>14</sup>

Prolonged disability before revascularization also appears to reduce the chances of return to work after surgery.<sup>52</sup> It has been suggested that the cumulative wait for coronary angiography and angioplasty or open-heart surgery may lead to major losses of productivity, delayed rehabilitation, and a reduced probability of return to previous levels of productivity.<sup>53</sup>

The data from the Person-Oriented Information Data Base show substantial variations in the rate of and the time to revascularization of heart attack patients by age, sex and province. This analysis is not intended to indicate whether revascularization rates are too low or too high, or whether time-to-procedure is too long or too short. Appropriate revascularization rates and waiting periods depend on the characteristics of each patient. Such information, notably on clinical severity, is not available from the Person-Oriented Information Data Base. However, the variations in the rate of and the time to revascularization of Canadian heart attack patients that were found in this first national study indicate that differences in patterns of practice and available resources may exist. ●

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## Appendix

Table A  
Number of heart attack patients hospitalized between April 1 and September 30, 1993, by age, sex and wash-out period, Canada excluding territories

| Age          | No wash-out period |               |              | Wash-out period† |              |              |
|--------------|--------------------|---------------|--------------|------------------|--------------|--------------|
|              | Total              | Men           | Women        | Total            | Men          | Women        |
| <b>Total</b> | <b>23,876</b>      | <b>15,218</b> | <b>8,658</b> | <b>15,384</b>    | <b>9,779</b> | <b>5,605</b> |
| 20-24        | 7                  | 5             | 2            | 7                | 5            | 2            |
| 25-29        | 27                 | 19            | 8            | 16               | 11           | 5            |
| 30-34        | 127                | 100           | 27           | 75               | 53           | 22           |
| 35-39        | 366                | 310           | 56           | 228              | 193          | 35           |
| 40-44        | 784                | 652           | 132          | 471              | 386          | 85           |
| 45-49        | 1,362              | 1,126         | 236          | 797              | 649          | 148          |
| 50-54        | 1,708              | 1,376         | 332          | 1,015            | 793          | 222          |
| 55-59        | 2,051              | 1,597         | 454          | 1,306            | 1,035        | 271          |
| 60-64        | 2,797              | 2,008         | 789          | 1,651            | 1,131        | 520          |
| 65-69        | 3,296              | 2,181         | 1,115        | 2,144            | 1,420        | 724          |
| 70-74        | 3,585              | 2,123         | 1,462        | 2,368            | 1,398        | 970          |
| 75-79        | 3,333              | 1,757         | 1,576        | 2,156            | 1,171        | 985          |
| 80-84        | 2,585              | 1,235         | 1,350        | 1,740            | 848          | 892          |
| 85-89        | 1,346              | 552           | 794          | 899              | 382          | 517          |
| 90-94        | 407                | 143           | 264          | 269              | 104          | 165          |
| 95+          | 90                 | 31            | 59           | 58               | 18           | 40           |

Data source: Person-Oriented Information Data Base

Note: Detail does not add to totals because of exclusion of a small number of patients younger than age 20.

† Excludes Nova Scotia and Quebec.

Table B  
Number of heart attack patients hospitalized between April 1 and September 30, 1993, based on a 12-month wash-out period, by sex, Canada, eight provinces

|                         | Total         | Men          | Women        |
|-------------------------|---------------|--------------|--------------|
| <b>Eight provinces†</b> | <b>15,384</b> | <b>9,779</b> | <b>5,605</b> |
| Newfoundland            | 557           | 337          | 220          |
| Prince Edward Island    | 101           | 65           | 36           |
| New Brunswick           | 715           | 457          | 258          |
| Ontario                 | 8,914         | 5,615        | 3,299        |
| Manitoba                | 789           | 492          | 297          |
| Saskatchewan            | 785           | 514          | 271          |
| Alberta                 | 1,469         | 966          | 503          |
| British Columbia        | 2,054         | 1,333        | 721          |

Data source: Person-Oriented Information Data Base

† Excludes Nova Scotia and Quebec.

Table C  
**Characteristics of heart attack patients hospitalized between April 1 and September 30, 1993, by province and wash-out period, Canada excluding territories**

|                      | No wash-out period |               |             |                       |             | 12-month wash-out period <sup>†</sup> |               |             |                       |             |
|----------------------|--------------------|---------------|-------------|-----------------------|-------------|---------------------------------------|---------------|-------------|-----------------------|-------------|
|                      | Female             | Aged<br>75-84 | Aged<br>85+ | 6-month<br>death rate |             | Female                                | Aged<br>75-84 | Aged<br>85+ | 6-month<br>death rate |             |
|                      |                    |               |             | Men                   | Women       |                                       |               |             | Men                   | Women       |
|                      | %                  |               |             |                       |             |                                       |               |             |                       |             |
| <b>Total</b>         | <b>36.3</b>        | <b>24.8</b>   | <b>7.7</b>  | <b>14.9</b>           | <b>23.3</b> | <b>36.4</b>                           | <b>25.3</b>   | <b>8.0</b>  | <b>16.1</b>           | <b>23.7</b> |
| Newfoundland         | 39.5               | 26.0          | 7.1         | 15.1                  | 17.9        | 39.5                                  | 24.4          | 7.2         | 14.5                  | 17.7        |
| Prince Edward Island | 35.5               | 21.8          | 10.0        | 12.7                  | 15.4        | 35.6                                  | 22.8          | 8.9         | 10.8                  | 13.9        |
| Nova Scotia          | 36.2               | 23.4          | 5.8         | 1.3                   | 3.5         | ...                                   | ...           | ...         | ...                   | ...         |
| New Brunswick        | 36.0               | 22.6          | 8.5         | 13.7                  | 25.1        | 36.1                                  | 21.3          | 8.3         | 12.9                  | 24.4        |
| Quebec               | 35.0               | 22.2          | 6.6         | 13.4                  | 25.1        | ...                                   | ...           | ...         | ...                   | ...         |
| Ontario              | 37.4               | 25.5          | 7.5         | 15.4                  | 22.9        | 37.0                                  | 25.1          | 7.4         | 15.5                  | 23.5        |
| Manitoba             | 38.3               | 26.9          | 11.9        | 16.1                  | 23.3        | 37.6                                  | 26.4          | 10.8        | 16.3                  | 23.9        |
| Saskatchewan         | 35.2               | 29.9          | 11.1        | 16.9                  | 27.1        | 34.5                                  | 28.8          | 9.7         | 17.3                  | 25.8        |
| Alberta              | 34.6               | 24.5          | 7.6         | 15.4                  | 22.3        | 34.2                                  | 23.8          | 7.5         | 15.7                  | 22.5        |
| British Columbia     | 35.4               | 27.6          | 9.3         | 20.1                  | 27.0        | 35.1                                  | 27.4          | 9.3         | 20.3                  | 26.6        |

**Data source:** Person-Oriented Information Data Base

<sup>†</sup> Excludes Nova Scotia and Quebec.

... Not applicable

Table D  
**Percentage of heart attack patients hospitalized between April 1 and September 30, 1993 who had revascularization procedure within six months, based on a 12-month wash-out period, by sex, Canada, seven provinces**

|                                    | Percutaneous<br>transluminal coronary<br>angioplasty (PTCA) |            |            | Coronary artery bypass<br>graft (CABG) |            |            | At least one<br>revascularization<br>procedure <sup>†</sup> |             |             |
|------------------------------------|---|------------|------------|--|------------|------------|---|-------------|-------------|
|                                    | Total   | Men        | Women      | Total                                  | Men        | Women      | Total   | Men         | Women       |
|                                    | %   |            |            |  |            |            |   |             |             |
| <b>Seven provinces<sup>‡</sup></b> | <b>8.0</b>  | <b>8.8</b> | <b>6.5</b> | <b>6.5</b>                             | <b>7.7</b> | <b>4.5</b> | <b>14.1</b>   | <b>16.1</b> | <b>10.7</b> |
| Newfoundland                       | 3.4   | 3.3        | 3.6        | 5.6                                    | 5.6        | 5.5        | 9.0   | 8.9         | 9.1         |
| New Brunswick                      | 9.2   | 11.2       | 5.8        | 5.7                                    | 6.6        | 4.3        | 14.5  | 17.1        | 10.1        |
| Ontario                            | 5.9   | 6.5        | 4.8        | 6.4                                    | 7.7        | 4.1        | 11.8  | 13.6        | 8.6         |
| Manitoba                           | 6.3   | 7.7        | 4.0        | 4.9                                    | 5.3        | 4.4        | 11.3  | 13.0        | 8.4         |
| Saskatchewan                       | 10.4  | 11.3       | 8.9        | 5.4                                    | 6.4        | 3.3        | 15.7  | 17.5        | 12.2        |
| Alberta                            | 18.3  | 18.6       | 17.7       | 8.4                                    | 10.1       | 5.0        | 26.5  | 28.7        | 22.5        |
| British Columbia                   | 10.6  | 12.2       | 7.6        | 7.7                                    | 8.4        | 6.5        | 17.8  | 20.1        | 13.5        |

**Data source:** Person-Oriented Information Data Base

<sup>†</sup> May be less than the sum of those with PTCA and CABG, as some patients had both.

<sup>‡</sup> Excludes Prince Edward Island, Nova Scotia and Quebec.

Table E

**Odds ratios relating revascularization procedures to age, sex and province, heart attack patients hospitalized between April 1 and September 30, 1993, based on a 12-month wash-out period, Canada, seven provinces†**

|                           | Percutaneous transluminal coronary angioplasty (PTCA) |                         | Coronary artery bypass graft (CABG) |                         | At least one revascularization procedure |                         |
|---------------------------|---|-------------------------|-------------------------------------|-------------------------|--|-------------------------|
|                           | Odds ratio  | 95% confidence interval | Odds ratio                          | 95% confidence interval | Odds ratio                               | 95% confidence interval |
| <b>Sex</b>                |   |                         |                                     |                         |  |                         |
| Men                       | 1.0   | 0.9, 1.1                | 1.4*                                | 1.2, 1.7                | 1.2*                                     | 1.1, 1.3                |
| Women‡                    | 1.0   | ...                     | 1.0                                 | ...                     | 1.0                                      | ...                     |
| <b>5-year age groups§</b> | 0.8*  | 0.8, 0.8                | 0.9*                                | 0.8, 0.9                | 0.8*                                     | 0.8, 0.8                |
| <b>Seven provinces</b>    |   |                         |                                     |                         |  |                         |
| Newfoundland              | 0.5*  | 0.3, 0.9                | 0.9                                 | 0.6, 1.3                | 0.7*                                     | 0.5, 1.0                |
| New Brunswick             | 1.5*  | 1.2, 2.0                | 0.8                                 | 0.6, 1.2                | 1.2                                      | 1.0, 1.5                |
| Ontario‡                  | 1.0   | ...                     | 1.0                                 | ...                     | 1.0                                      | ...                     |
| Manitoba                  | 1.2   | 0.9, 1.6                | 0.8                                 | 0.6, 1.1                | 1.0                                      | 0.8, 1.3                |
| Saskatchewan              | 2.1*  | 1.7, 2.7                | 0.9                                 | 0.6, 1.2                | 1.6*                                     | 1.3, 1.9                |
| Alberta                   | 3.7*  | 3.1, 4.3                | 1.3*                                | 1.1, 1.6                | 2.8*                                     | 2.4, 3.2                |
| British Columbia          | 2.1*  | 1.8, 2.5                | 1.3*                                | 1.1, 1.6                | 1.8*                                     | 1.6, 2.0                |

**Data source:** Person-Oriented Information Data Base

**Note:** The analyses were based on 15,283 cases.

† Excludes Prince Edward Island, Nova Scotia and Quebec.

‡ Reference category, for which odds ratio is always 1.0

§ Coded from low to high

... Not applicable

\*  $p < 0.05$