

## Coronary artery bypass grafting in Canada: What is its rate of use? Which rate is right?

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We reviewed recent reports from administrative databases and clinical registries addressing the utilization of coronary artery bypass grafting (CABG) in Canada. The Canadian CABG rate per 100 000 people increased from 31.1 to 43.2 between 1981–82 and 1986–87. Between 1981 and 1986 the rate in the United States increased from 69.9 to 95.3 per 100 000, consistently about two times the Canadian rate. Provincial data have shown particular growth in utilization among elderly people. However, in the United States the 1985 CABG rate was twice as high as the aggregated age-specific rates for Ontario and Manitoba among people 65 to 74 years of age and four times higher among those 75 years or more. Limited registry data suggest that the Canadian CABG case mix is similar to the case mix in major US centres and that, utilization growth notwithstanding, the procedure is largely applied to patients who should, in theory, benefit (i.e., those with severe angina, impaired left ventricular function and left main-stem or triple-vessel disease). However, chart audits and registry evaluations using explicit criteria are needed to compare the use of CABG in Canada and the United States. In addition, Canadian data show moderate regional and municipal variations, the 1986–87 rates per 100 000 population in major census metropolitan areas varying from 19.5 to 46.9. Areas with consistently low rates raise particular concerns about impaired access to CABG. Reasons for variations should therefore be a research priority.

Nous avons examiné de récents rapports issus de bases de données administratives et de registres cliniques traitant de l'utilisation du pontage aortocoronarien (PAC) au Canada. Chez les Canadiens, le taux de PAC par 100 000 personnes a augmenté de 31,1 à 43,2 entre 1981–1982 et 1986–1987. Aux États-Unis, entre 1981 et 1986, le taux a augmenté de 69,9 à 95,3 par 100 000, constamment deux fois environ le taux canadien. Les données provinciales ont indiqué une croissance particulière de l'utilisation chez les personnes âgées. Cependant, aux États-Unis, le taux de PAC de 1985 était deux fois plus élevé que les taux cumulatifs selon l'âge en Ontario et au Manitoba chez les personnes de 65 à 74 ans et quatre fois plus élevé chez celles de 75 ans ou plus. Les données fragmentaires des registres suggèrent que le mélange de cas de PAC au Canada est semblable à celui des principaux centres américains et que, malgré la croissance de l'utilisation, l'intervention s'adresse dans une large mesure aux patients qui peuvent théoriquement en tirer parti (c.-à-d. ceux qui sont atteints d'angine grave, d'insuffisance ventriculaire gauche et d'une atteinte de la souche principale gauche ou triple vasculopathie). Cependant, la vérification des tableaux et l'évaluation des registres au

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moyen de critères explicites sont nécessaires pour comparer l'utilisation du PAC au Canada et aux États-Unis. De plus, les données canadiennes témoignent de variations modestes entre les régions et les villes; les taux de 1986-1987 par 100 000 personnes varient de 19,5 à 46,9 dans les principales régions métropolitaines selon le recensement. Les régions dont les taux sont constamment bas soulèvent des inquiétudes particulières au regard d'une mauvaise accessibilité du PAC. Les motifs des variations devraient donc être une priorité de recherche.

**A**lthough randomized trials in surgery have been more the exception than the rule coronary artery bypass grafting (CABG) has been compared with medical therapy in three large trials and several smaller studies.<sup>1,2</sup> CABG can prolong life in some groups of patients and may improve the quality of life for others. However, few procedures have engendered as much controversy or misunderstanding. Waiting lists for CABG and other open-heart procedures emerged in the late 1980s; they have concerned health care providers and patients alike and are perceived by US observers as evidence of rationing in the Canadian medicare system.<sup>3</sup> At the same time, critics have challenged the growing use of the operation (*Globe and Mail*, Toronto, Sept. 8, 1990: A4).<sup>4</sup> "Official" misinformation is also evident. For example, a 1990 Ontario budget paper claimed (falsely) that "cardiovascular surgery is the most frequently performed surgery in Ontario."<sup>5</sup>

We reviewed the recent Canadian literature to address two questions. At what rate is the procedure being used and how have patterns of utilization changed? To answer these questions we had to assess how often the procedure is performed in various populations in Canada; this leads logically to a third, more difficult question. Given that rates vary within and between nations, which rate is right? We reviewed relevant studies and have created a possible agenda for further investigation.

## Patterns of CABG use

In a prospective registry report Christakis and associates<sup>6</sup> outlined the changing pattern of CABG in the three surgical centres associated with the University of Toronto. Only cases in which CABG was performed alone were analysed. A total of 7334 patients were accrued from 1982 through 1986. The proportion of patients over 70 years of age who underwent surgery increased steadily, from 2% of the annual caseload in 1982 to 7% in 1986. The proportion over 65 years grew more dramatically, from 14% in 1982 to 27% in 1986. The male-female ratio was about 4:1.

The only other recent CABG registry report from Canada was by Morin and collaborators,<sup>7</sup> from the Royal Victoria Hospital in Montreal. Between 1982 and 1988 data were collected on 2750 open-heart procedures, CABG accounting for 1978

(71.9%) of them. In comparing the data for 1982 to 1987 with those for 1988 the authors found more reoperations in 1988 (6% v. 9%,  $p = 0.049$ ) but no change in the mean age of patients. Comparison of the 1988 Royal Victoria patients with a 1986 subgroup of Toronto patients showed no difference except in utilization of internal mammary grafts and the rate of reoperation (the latter being 9.0% v. 5.8% respectively).

Registries are invaluable in compiling clinical profiles of patients undergoing procedures at specific institutions. However, because most hospitals that offer cardiac surgery serve as regional referral centres the applicable denominator for hospital registries is uncertain; thus, utilization rates can be calculated only with the use of data from provincial or national registries, which do not currently exist for CABG. Until they are established the main data sources for monitoring rates of CABG are computer databases of hospital discharge abstracts or medicare claims.

In the few available publications reviewing these administrative databases it was not stated whether patients undergoing concomitant procedures (e.g., valve replacement and aneurysmectomy) were excluded. All patients were apparently included provided that the CABG code appeared in the computer database.

Anderson and Lomas<sup>8</sup> used discharge abstracts for Ontario obtained from the Hospital Medical Records Institute (HMRI) to track CABG utilization from the fiscal years 1979-80 to 1985-86. The rate per 100 000 people over 20 years of age increased by 39% between 1979-80 and 1983-84 and then reached a plateau. The rate among people 65 to 69 years of age doubled, and the rate among those over 70 increased more than fivefold. Consequently, the proportion of procedures in the population over 65 years of age rose from 12.8% in 1979-80 to 27.4% in 1985-86. Table 1 shows the relevant rates in the entire population.

Roos and Sharp<sup>9</sup> examined the use of CABG in Manitoba from 1977-78 to 1983-84. The rate per 100 000 people over 25 years of age increased from 20 to 59. Utilization growth among elderly patients was less pronounced than in Ontario. A major difference in the rate between men and women was again noted: in 1983-84 the rates were 93 and 27 per 100 000 respectively.

A recent report from Statistics Canada<sup>10</sup> offers a national overview. Between 1981–82 and 1986–87 there was a 39% increase in the national rate of CABG, from 31.1 to 43.2 per 100 000. This included a brief plateau during 1984–85 followed by more modest growth through 1985–87. The national data confirmed a major increase in the frequency of CABG among elderly people. Those over 75 years of age still accounted for a very small proportion of the overall caseload — less than 5% in 1986–87. In 1986–87 the highest age-specific rate among women was found for those 65 to 74 years, whereas among men the peak rate continued to be for those 55 to 64.

Provincial rates were standardized to control for differences in age and sex. The rates per 100 000 people in 1986–87 were reported as follows: Newfoundland 48.8, Nova Scotia 59.5, Quebec 49.3, Ontario 45.3, Manitoba 43.2, Saskatchewan 33.6, Alberta 27.2 and British Columbia 39.0.<sup>10</sup>

### Comparisons between Canada and the United States

Using their registry data Morin and collaborators<sup>7</sup> compared the clinical profiles of their patients in 1988 with those reported for the same year from the St. Louis Jewish Hospital. Of the features that were compared the only statistically significant differences were in the proportion of patients with Canadian Cardiovascular Society class IV stable angina<sup>11</sup> (63% in St. Louis v. 42% in Montreal) and the proportion of emergency operations performed (4% v. 17% respectively). The latter feature, however, may reflect differing definitions of emergency and the ability of US centres to offer CABG with minimal waiting. The similarity in patient profiles is evidence against the assumption that the higher rates of CABG in the United States stem from treatment of less severe cases, which represent uncertain indications for the procedure. Morin and collaborators suggested that the converse is likely true — namely, that Canadians who might benefit from CABG are not receiving it.

Table 1: Rates of coronary artery bypass grafting (CABG) per 100 000 population in Ontario from 1979–80 to 1985–86\*

Year	Rate
1979–80	28.6
1981–82	34.3
1983–84	41.5
1985–86	41.0

\*The data were obtained from reference 8 and adjusted for the entire population.

Drawing on administrative data sets Anderson, Newhouse and Roos<sup>12</sup> compared the frequency of cardiovascular procedures among elderly people in Canada and the United States. Data from Manitoba and Ontario for the fiscal years 1981–82 and 1985–86 were compared with US data from a sample of 20% of all claims submitted to the Medicare program in the calendar year 1981 and the fiscal year 1985–86. Table 2 shows the key findings with respect to CABG. Although the two countries experienced about a doubling in the use of CABG in elderly people, the increase was slightly greater in the United States. Thus, major rate differences — two-fold among people between 65 and 74 years and almost fourfold among those over 75 years — persisted. Such differences were not demonstrated with valve surgery or pacemaker insertion.

In comparing the national and provincial rates for all age groups reported by Peters and colleagues<sup>10</sup> with the US rates<sup>13</sup> we noticed that, just as for elderly people,<sup>12</sup> a sustained increase in the number of revascularization procedures has maintained the cross-border difference in rates. The US data, drawn from the National Hospital Discharge Survey,<sup>13</sup> indicated that between 1981 and 1986 the rate of CABG procedures increased by 36%, from 69.9 to 95.3 per 100 000. The US rate remained about two times the Canadian rate. Table 3 shows the 1985 rates per 100 000 population in various European countries (Dr. Ingrid Martin, World Health Organization: personal communication, 1991). Currently, although the US rate can be projected at well over 100 per 100 000 the British rate has been estimated to be less than 25 per 100 000 population.<sup>14</sup>

### Are the data valid?

The accuracy and precision of data in prospective registry studies can be verified with the use of manoeuvres commonly applied in clinical research (e.g., use of standard definitions, random double-checking of records, overreading of angiograms and chart audits). Although none of the Canadian regis-

Table 2: Rates of CABG per 100 000 elderly people in Canada and the United States<sup>12</sup>

Year; country	Age group, yr; rate			% increase
	65–74	≥ 75	All	
1981–82				
Canada	76	9	50	–
United States*	146	32	101	–
1985–86				
Canada	141	25	94	188
United States	296	100	217	215

\*US data were for the calendar year 1981.

try reports<sup>6,7</sup> specified whether such measures were taken peer acceptance and the congruence of findings between the studies attest to their probable validity.

When rates are calculated with the use of administrative data, errors, apart from misinterpretations if the populations under study are not described clearly enough,<sup>15</sup> can occur if either the numerator or the denominator is inaccurate. For denominators census data are widely available, and interpolation between census years is straightforward. There are three main sources of error in determining the numerator (number of procedures) from administrative data: (a) miscoding of the procedure, (b) residence-related errors, with inappropriate allowance for procedures performed out of province or outside Canada and (c) programming errors in the extraction of the actual number of procedures from the data tapes.

Although coding of cardiovascular diagnoses in hospital charts is associated with moderately high error rates<sup>16-19</sup> inaccurate coding of CABG is probably uncommon. For example, Roos and Sharp<sup>9</sup> found that the hospital discharge abstracts and the medical claims for cardiovascular surgical procedures over several years were in agreement 95% to 98% of the time.<sup>9,19</sup>

Province-wide hospital discharge records are subject to residence-related errors because of patients' movement between provinces. Residence status was not considered in the provincial rates reported by Peters and colleagues.<sup>10</sup> The impact is minimal in most provinces. For example, Ontario residents account for over 95% of all open-heart or CABG procedures performed in hospitals in that province;

an extra 4% to 5% from other provinces is at least partially offset by referrals from northwestern Ontario to Manitoba. However, the rate in Nova Scotia is markedly affected. Since neither New Brunswick nor Prince Edward Island had CABG facilities in the period reviewed by Peters and colleagues referrals were made principally to Halifax. This explains why the authors did not report provincial rates for New Brunswick and Prince Edward Island and why the rate in Nova Scotia was the highest in Canada (59.5 per 100 000 population); the residence-corrected rates for the Halifax metropolitan area were the lowest of any major city in Canada (the data for metropolitan centres reported by Peters and colleagues were for residents of those centres only).

The need to track interprovincial movement of cases becomes more important when small-area analyses for cities or regions bordering on other provinces are done. For example, the movement of patients to Manitoba (and perhaps to Michigan) from northwestern Ontario must be considered as a confounder when the rates of open-heart surgery in that region are found to be less than half the provincial average if Ontario hospital discharge data are analysed alone (unpublished observations).

A related source of error is CABG performed outside Canada. Before 1985 it was estimated that less than 2% of Ontario residents undergoing CABG procedures did so outside the province, in either the United States or another province.<sup>8</sup> In 1989-90 and 1990-91, 200 to 300 Ontario residents each year had open-heart surgery in the United States (Gordon Kumagai, cardiovascular coordinator, Ontario Ministry of Health: personal communication, 1991). These people accounted for less than 5% of patients undergoing open-heart surgery in Ontario and are therefore of minor influence overall. However, if most were elderly people who spend the winter in the southern United States, there would be some effect on age-specific rates.

Finally, programming or search-strategy errors can occur. Even minor variations in search strategies can radically alter rate calculations. For example, the National Hospital Discharge Survey in the United States is a cross-sectional survey of a random sample of hospitals that draws on discharge abstracts coded under the clinical modification of the *International Classification of Diseases*, 9th revision.<sup>20</sup> Coding practices are such that surgery involving the internal mammary artery is listed separately from saphenous vein bypass grafting; therefore, double counting is inevitable unless specific search strategies are used. Feinlieb and coworkers<sup>13</sup> noted that inappropriate search strategies would lead to an overestimate of 284 000 instead of 228 000 CABG procedures performed in 1986; the overestimate has been reported

Table 3: Rates of CABG per 100 000 population in Europe in 1985\*

Country	Rate
The Netherlands	48.0
Belgium	33.8
Switzerland	25.3
Sweden	24.6
Norway	20.0
Britain	18.5
West Germany	17.0
Italy	15.3
Austria	12.5
France	12.0
Spain	12.0
Finland	11.5
Portugal	7.7
East Germany	6.2
Hungary	3.0

\*The rates are based on data from the World Health Organization (Dr. Ingrid Martin: personal communication, 1991).

in some influential nonacademic publications (*Wall Street Journal*, New York, May 11, 1990: R15).<sup>21</sup>

Canadian coding is associated with similar problems: Canadian Classification of Surgical Procedures codes 48.12 to 48.15 deal with different numbers of arteries bypassed with saphenous vein grafts, whereas codes 48.16 and 48.17 are for procedures involving single and double internal mammary artery grafts.<sup>22</sup> However, Canadian published data (and all unpublished analyses in our possession) are based on hospital separations (i.e., discharges, transfers and deaths) rather than on the number of procedures; therefore, the appearance of two or more different CABG codes on the same separation document should not be a problem. Nevertheless, full details on search strategies are seldom provided by investigators using administrative data; this shortcoming should be addressed in future.

### How do CABG rates vary?

Because hospital discharge abstracts give the patient's place of residence rates can be calculated by county or region. Since variations in rates are already evident at the provincial level it is not surprising that there are also small-area variations. Any data to be compared across populations should ideally be adjusted for age and sex. These adjustments control for the fact that CABG rates are lower among women than among men and that they might reasonably be expected to be higher in a retirement community than in one with a more usual demographic profile.

To examine variations in CABG rates in southern Ontario counties Anderson and Lomas<sup>23</sup> analysed HMRI data for 1979, 1981, 1983 and 1985. They found no relation between distance from the nearest CABG referral centre and county-specific age-adjusted rates. This supports the notion that regionalization can be undertaken without access being impeded. However, they noted substantial variations in age-adjusted rates by county of origin. Rates were considerably higher in specific centres than in others. Counties that were generally served by hospitals in three cities had rates below the provincial average (45 to 50 per 100 000 people over 20 years of age), as compared with counties that referred cases to two other cities (70 to 80 per 100 000 people over 20).

In Manitoba rising CABG rates were associated with increases in regional discrepancies, so that absolute and relative differences between areas with high rates (e.g., Winnipeg) and those with lower rates were magnified.<sup>9</sup> For example, in 1983-84 Winnipeg's rate per 100 000 adults was 72, as compared with 30 in western Manitoba and 27 in the Parkland region. Regional CABG variations could not be

consistently correlated with variations in diagnostic codes for acute myocardial infarction as a cause of either hospital admission or death. The use of coronary angiography paralleled the CABG variations closely, as would be expected.

Peters and colleagues<sup>10</sup> used residence codes to track CABG rates among people in 12 major census metropolitan areas. Table 4 shows the age-adjusted rates per 100 000 population for the first and last fiscal years of the study. Rates for cities that fell between the highest and lowest rates varied more than twofold in the 2 years.

### Discussion

The first half of the 1980s saw substantial growth in the utilization of CABG in Canada, particularly among elderly people. Data shedding light on rate trends during the latter part of the decade have not been published, but the emergence of waiting lists for CABG in many parts of Canada is compatible with one of two similar hypotheses. Either the rates reached a plateau in the face of rising demand, or they grew at an insufficient pace to keep abreast of demand. Although the recent infusion of resources into CABG facilities in New Brunswick, Quebec, Ontario and British Columbia should shorten waiting lists it will inevitably drive rates higher.

One might speculate that a rise in the CABG rate would be associated with extension of the procedure to increasing numbers of patients with less severe disease, who have less to gain. However, the Toronto registry report<sup>6</sup> suggests otherwise: it showed a significant increase in the number of procedures performed urgently in the face of unstable angina (from 11% to 19%) and little change in the number of patients with either left main-stem dis-

Table 4: Age-adjusted rates of CABG per 100 000 population by major census metropolitan area for 1981-82 and 1986-87<sup>24</sup>

Area	Year; rate	
	1981-82	1986-87
Halifax	20.9	28.5
Quebec	25.5	38.5
Montreal	29.1	46.9
Ottawa-Hull	50.5	42.2
Toronto	27.4	32.9
Hamilton	22.5	31.0
London	28.6	36.1
Winnipeg	25.3	35.9
Regina	29.6	41.4
Saskatoon	19.7	19.5
Edmonton	27.9	24.3
Vancouver	28.1	30.6

ease or triple-vessel disease (from 85% to 82%). In Montreal Morin and collaborators<sup>7</sup> reported that 65% of their patients had impaired left ventricular function — another prognostic variable associated with greater surgical benefit. US registry reports have shown a similar pattern.<sup>25,26</sup> Part of this shift may be attributable to the number of patients over 65 years of age, who likely have more advanced coronary artery disease.

Reasons for the growth in demand for CABG remain unclear. The incidence of coronary artery disease has not increased.<sup>27</sup> Prevalence may have grown relative to incidence, since treatment has improved for various disease-related events and conditions. However, the increase in the CABG rate is too great and too rapid to be readily attributed to a change in the natural history of coronary artery disease. In addition, the first phase of the rate increase precedes the diffusion of such innovations as thrombolytic therapy for acute myocardial infarction, which unlike conventional treatment may result in a greater use of mechanical revascularization.<sup>28</sup> The rate growth was not due to repeat procedures. In the Toronto registry report<sup>6</sup> the increase in the proportion of reoperations, from 4.6% to 5.8% of the isolated CABG caseload, was statistically significant but far too small to account for the observed trends. Finally, the increased use of percutaneous transluminal coronary angioplasty (PTCA) in Canada<sup>10</sup> in theory should either not affect the CABG rate at all or, more likely, contribute to a decrease in CABG utilization. Yet the continued increase in Canadian demand in the late 1980s is much in keeping with the experience in the United States, where far more explosive growth in the use of PTCA<sup>13</sup> has not moderated CABG utilization.

In the absence of adequate research evidence we hypothesize that the growth in CABG rates was due in part to three interrelated factors: (a) the inevitable diffusion of the surgical procedure itself, with greater enthusiasm from health care providers and patients about operating on those at higher risk as the procedure's safety and apparent effectiveness became known; (b) more intensive investigation of coronary artery disease, with an increased use of noninvasive techniques (e.g., exercise and electrocardiography, dipyridamole thallium scintigraphy, echocardiography and radionuclide ventriculography) and subsequent initiation of referrals to angiography and CABG centres; and (c) a greater willingness to subject patients to coronary angiography as its safety also became better established. All three factors would be important in increasing CABG use among elderly patients, who might be expected to have a higher prevalence of coronary artery disease than younger people.

The period beyond the mid-1980s needs to be

studied to determine whether the shift in utilization toward the elderly population is continuing. However, the early growth was predominantly in the "young old." Although the relative growth in the rate of CABG among those aged 75 years or more was striking, this group actually constituted only about 5% of the total caseload in Canada. Senior surgeons have noted that the high (and perhaps misplaced) expectations of the "young old" could play a role in diffusion patterns. Lytle,<sup>29</sup> a surgeon at the Cleveland Clinic, claimed that "patients in their 70s and 80s are just not willing to accept the limitations in activity level or life span associated with severe coronary artery disease." Indeed, the elderly sub-population has actually had a clinical picture in which medical therapy is less likely to be advantageous; for example, extensive coronary artery disease with triple-vessel stenosis or left main-stem lesions or both, impaired left ventricular function and severe stable angina or unstable angina.<sup>30</sup> The availability of PTCA may also be accelerating this change in case mix by skimming off the younger patients with limited coronary artery disease.<sup>26,31</sup> In any event it is the clear increase in the surgical rate of death and illness among elderly patients<sup>6</sup> that has raised some concerns about the risk-benefit ratio of surgery versus medical therapy.

Controversies about specific age groups aside, two observations are pertinent. First, the Canadian age shifts appear to parallel those in the United States. Second, even if recent capacity increases result in a national CABG rate of 60 per 100 000 the Canadian rate will remain well below the US rate. Such international and regional differences in the rates of many surgical procedures have been the subject of research for two decades.<sup>32</sup> The rhetorical question posed by Wennberg<sup>33</sup> — Which rate is right? — remains unanswered not only for CABG but also for a plethora of other procedures.

Pioneering work in this field has been done by researchers with the Rand Corporation, who have used formal expert panels to rate hypothetical cases in order to derive explicit criteria for the appropriate use of various procedures.<sup>34,35</sup> Each panel's deliberations were supported by a detailed literature review. Indications for CABG were among the first to be derived through such a process.<sup>1</sup> Application of these criteria to a random sample of 386 patients undergoing CABG at three hospitals in a western US state in 1979, 1980 and 1982 showed that only 14% of the procedures were deemed inappropriate. Appropriate indications were present in 56%, whereas uncertain indications were evident in 30%.<sup>36</sup> Rand Corporation researchers ran a similar panel process in the Trent region of Britain.<sup>14</sup> As expected British clinicians were found to be more conservative than their US counterparts. When applied to the same group of

386 US patients the British criteria suggested that in 35% of the cases the indications were inappropriate.

A second British panel was established to update the criteria in the Trent region. An audit of 319 patient charts from 1987–88 showed that the indications were appropriate in 58% of cases, equivocal in 26% and inappropriate in 16%. These results are of particular interest, because the rate of CABG in the Trent region was low (11 per 100 000 in 1985), even by British standards. Hence, the findings indicate that low CABG rates do not necessarily mean more appropriate utilization.<sup>37</sup>

In continuing this comparative work a new cooperative initiative has been launched with researchers from Canada (C.D.N., G.M.A. and Dr. Leslie L. Roos) and the Rand Corporation. Expert panels of practising physicians in the United States and Canada have reviewed the evidence on benefits and risks of coronary revascularization (both CABG and PTCA) and independently rated clinically detailed indications. Applied to actual practice patterns through chart reviews and prospective registry studies these explicit criteria will provide insights into Canadian-US differences in procedural decision-making and will set contemporary benchmarks against which utilization patterns can be assessed.

As well as helping to clarify how different countries use CABG, explicit criteria for appropriate surgery facilitate comparative analyses across smaller regions. Previous analyses of other medical and surgical procedures have not shown a consistent or strong relation between the proportion of appropriate procedures and the rate of use.<sup>38–40</sup> Such relations have not been explored for CABG in Canada or the United States. However, if high regional CABG rates are shown not to correlate closely with inappropriate utilization, factors other than surgical case selection, notably the capacity of referral centres and the practice patterns of referring physicians and angiographers, will need to be examined. Regional use of CABG is clearly the product of a complex process involving identification of those with clinical coronary artery disease, referral for noninvasive testing, a decision to perform angiography and finally referral to a cardiac surgeon. Research is thus needed to determine the effects of both the surgical spout and the medical funnel on CABG rate variations.

Finally, outcome research should help to determine the impact of differing rates of CABG both within and between countries. We do not know whether high CABG rates are associated with low rates of death from coronary artery disease or whether significant differences in illness from such disease (as measured, for example, in days off work and symptom status appraisals) are clearly demonstrated when CABG is more liberally used.

## Conclusions

CABG has been more rigorously tested and more closely scrutinized than most diagnostic or therapeutic procedures, and its delivery in Canada has generally been in a framework of regional planning. Although reliable and valid data sources are available to provide some sense of current utilization patterns, more data are needed. Moreover, we remain unable to answer the key question: Which CABG rate is right?

Overused in the eyes of some critics and underused to the point of national embarrassment in the eyes of others, CABG can be seen as an indicator of fundamental deficiencies in our understanding of Canadian health care. Certain concepts for improving care in the 1990s have been noted in this article, including more registry studies with intercentre linkage, detailed studies of referral patterns and service delivery by region, development of criteria for appropriate utilization, and assessment of actual delivery practices relative to ideals with the use of registry data, hospital discharge data and medicare claims data.

Table 5 summarizes these concepts and issues of related health services research into CABG. Similar research is needed into other major cardiovascular procedures, most notably coronary angiography and PTCA. Indeed, much the same research agenda could be proposed for procedures in many special-

Table 5: Suggested priorities for health services research into the use of CABG in Canada

- Establish contemporary indications for CABG through provider consensus processes
- Use consensus indications to assess appropriateness of current utilization patterns through chart reviews and comparisons with registry data
- Analyse the role of local practice and referral patterns in generating small-area variations and develop strategies to reduce variability
- Analyse areas with low CABG rates to determine whether there is implicit rationing or underutilization of the procedure
- Perform additional validation studies on secondary databases (e.g., hospital discharge abstracts and medicare claims) and improve reporting of rates based on these sources
- Implement provincial registries for CABG and other cardiovascular procedures
- Monitor effects of expansion of CABG facilities (e.g., in New Brunswick, Ontario, Quebec and British Columbia) on waiting lists and surgical rates
- Continue research into alternatives to CABG (e.g., percutaneous transluminal coronary angioplasty and medical therapy) and their impact on CABG utilization and health status
- Assess utilization of CABG by sex, age and socioeconomic status
- Assess outcomes of CABG (i.e., rates of illness and death)

ties. Without a quiet revolution in management and information systems, and without a more active agenda in clinical epidemiologic and health services research, we believe the problems and controversies that surround CABG utilization will not only continue but also engulf a growing number of sectors and services in Canadian health care.

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## References

1. Chassin MR, Park RE, Fink A et al: *Indications for Selected Medical and Surgical Procedures — a Literature Review and Ratings of Appropriateness: Coronary Artery Bypass Graft Surgery* (Rand R-3204/2CWF/HF/PMT/RWJ), Rand Corp, Santa Monica, Calif, 1986
2. Rahimtoola SH: A perspective on the three large multicenter randomized clinical trials of coronary bypass surgery for chronic stable angina. *Circulation* 1985; 72 (6 pt 2): V123-V135
3. Naylor CD: A different view of queues in Ontario. *Health Aff (Millwood)* 1991; 10 (3): 110-128
4. Morgan PP, Cohen L: The Ottawa Heart Institute: It's good, but can we afford it? *Can Med Assoc J* 1990; 142: 616-620
5. *The Costs of Public Services* (Ontario budget paper E), Govt of Ontario, Toronto, 1990: 63
6. Christakis G, Ivanov J, Weisel RD et al: The changing pattern of coronary artery bypass surgery. *Circulation* 1989; 80 (suppl I): I-151-I-161
7. Morin JE, Symes JF, Guerraty AJ et al: Coronary artery bypass profile in Canada and the United States. *Can J Cardiol* 1990; 6: 319-322
8. Anderson GM, Lomas J: Monitoring the diffusion of a technology: coronary artery bypass surgery in Ontario. *Am J Public Health* 1988; 78: 251-254
9. Roos LL, Sharp SM: Innovation, centralization, and growth: coronary artery bypass graft surgery in Manitoba. *Med Care* 1989; 27: 441-452
10. Peters S, Chagani K, Paddon P et al: Coronary artery bypass surgery in Canada. *Health Rep* 1990; 2 (1): 9-26
11. Campeau L: Grading of angina pectoria [C]. *Circulation* 1975; 54: 522-523
12. Anderson GM, Newhouse JP, Roos LL: Hospital care for elderly patients with diseases of the circulatory system: a comparison of hospital use in the United States and Canada. *N Engl J Med* 1989; 321: 1443-1448
13. Feinlieb M, Havlik RJ, Gillum RF et al: Coronary heart disease and related procedures. National Hospital Discharge Survey data. *Circulation* 1989; 79 (suppl I): I-13-I-18
14. Brook RH, Kosecoff JB, Park RE et al: Diagnosis and treatment of coronary artery disease: comparison of doctors' attitudes in the USA and the UK. *Lancet* 1988; 1: 750-753
15. Naylor CD: Coronary artery bypass surgery rates in Ottawa [C]. *Can Med Assoc J* 1990; 143: 1287
16. Van Walraven C, Wang B, Ugnat AM et al: False-positive coding for acute myocardial infarction on hospital discharge records: chart audit results from a tertiary centre. *Can J Cardiol* 1990; 6: 383-386
17. Iezzoni LI, Burnside S, Sickles L et al: Coding of acute myocardial infarction: policy implications. *Ann Intern Med* 1988; 109: 745-751

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18. Nova Scotia-Saskatchewan Cardiovascular Disease Epidemiology Group: Estimation of the incidence of acute myocardial infarction using record linkage: a feasibility study in Nova Scotia and Saskatchewan. *Can J Public Health* 1989; 80: 412-417
19. Roos LL, Sharp SM, Wajda A: Assessing data quality: a computerized approach. *Soc Sci Med* 1989; 28: 175-182
20. *International Classification of Diseases* (clinical modification), 9th rev, US Dept of Health, Education, and Welfare, Public Health Service, Ann Arbor, Mich, 1978
21. Souhrada L: Hospitals pursue heart programs — despite pitfalls. *Hospitals* 1989; Oct 20: 40-45
22. *Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures* (cat 82-562E), Statistics Canada, Ottawa, 1986: 189-190
23. Anderson GM, Lomas J: Regionalization of coronary artery bypass surgery. Effects on access. *Med Care* 1989; 27: 288-296
24. Addendum: coronary artery bypass surgery in Canada [*Health Rep* 1990; 2 (1): 9-26]. *Health Rep* 1990; 2 (2): 175
25. Naunheim KS, Fiore AC, Wadley JJ et al: The changing profile of the patient undergoing coronary artery bypass surgery. *J Am Coll Cardiol* 1988; 11: 494-498
26. Davis PK, Parascandola SA, Miller CA et al: Mortality of coronary artery bypass grafting before and after the advent of angioplasty. *Ann Thorac Surg* 1989; 47: 493-498
27. Martin CA, Hobbs MST, Armstrong BK et al: Trends in the incidence of myocardial infarction in Western Australia between 1971 and 1982. *Am J Epidemiol* 1989; 129: 655-668
28. Naylor CD, Jaglal SB: Impact of intravenous thrombolysis on short-term coronary revascularization rates: a meta-analysis. *JAMA* 1990; 264: 697-702
29. Lytle BW: Mortality of coronary artery bypass grafting before and after the advent of angioplasty. Discussion. *Ann Thorac Surg* 1989; 47: 497
30. Acinapura AJ: Mortality of coronary artery bypass grafting before and after the advent of angioplasty. Discussion. *Ibid*: 498
31. King SB, Talley JD: Coronary arteriography and percutaneous transluminal coronary angioplasty. Changing patterns of use and results. *Circulation* 1989; 79 (suppl I): I-19-I-23
32. Folland S, Stano M: Small area variations: a critical review of propositions, methods, and evidence. *Med Care Rev* 1990; 47: 419-465
33. Wennberg J: Which rate is right [E]? *N Engl J Med* 1986; 314: 310-311
34. Park RE, Fink A, Brook RH et al: Physician ratings of appropriate indications for six medical and surgical procedures. *Am J Public Health* 1986; 76: 766-772
35. Brook RH, Chassin MR, Fink A et al: A method for the detailed assessment of the appropriateness of medical technologies. *Int J Tech Assess Health Care* 1986; 2: 53-64
36. Winslow CM, Kosecoff JB, Chassin M et al: The appropriateness of performing coronary artery bypass surgery. *JAMA* 1988; 260: 505-509
37. Gray D, Hampton JR, Bernstein SJ et al: Audit of coronary angiography and bypass surgery. *Lancet* 1990; 335: 1317-1320
38. Chassin MR, Kosecoff J, Park RE et al: Does inappropriate use explain geographic variations in the use of health care services? A study of three procedures. *JAMA* 1987; 258: 2533-2537
39. Roos NP, Roos LL, Henteleff PD: Elective surgical rates: Do high rates mean lower standards? *N Engl J Med* 1977; 297: 360-365
40. Leape LL, Park RE, Solomon DH et al: Does inappropriate use explain small-area variations in the use of health care services? *JAMA* 1990; 263: 669-672



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(artist's interpretation)



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