Benchmarking the vital risk of waiting for coronary artery bypass surgery in Ontario

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Abstract

Background: Deaths among patients awaiting coronary artery bypass grafting (CABG) are a source of private grief and public concern in Canada. However, some deaths are expected over time among patients with coronary artery disease. Methods of benchmarking the burden of delayed care may be useful in understanding and managing waiting lists for CABG and other health services. The authors therefore determined the vital risk among people waiting for CABG in Ontario and compared it with the risk in the general population and among people living with coronary artery disease.

Methods: Patients registered to undergo CABG in Ontario between 1991 and 1995 were followed to ascertain numbers and dates of preoperative deaths or completed operations. Linking hospital discharge abstract data to vital statistics for 1991 to 1994, the authors defined a cohort of people who had survived 6 months after an acute myocardial infarction (AMI) and followed them for an additional 6 months to determine numbers and dates of deaths. They matched patients by age and sex and then calculated the standardized mortality ratio for each cohort (i.e., the ratio of observed deaths to those expected based on age- and sex-specific daily probabilities of death for the provincial population).

Results: Among 21 220 patients awaiting CABG, there were 82 preoperative deaths over a median follow-up of 18 days; the standardized mortality ratio was 2.92 (95% confidence limit [CL] 2.29–3.55). Among 21 220 matched 6-month survivors of an AMI, there were 663 deaths over a median follow up of 185 days; the standardized mortality ratio was 3.84 (95% CI 3.54–4.14).

Interpretation: Patients awaiting CABG in Ontario are at a much greater risk of death than the general population. However, when compared with thousands of other patients living with coronary artery disease, they are at similar or decreased vital risk.

Deaths of people awaiting coronary artery bypass grafting (CABG) have been a flashpoint for public and professional concern in the Canadian health care system.[1–3] Ontario data show that about 1 in 250 patients scheduled for CABG die preoperatively.[4,5] These patients are "identifiable victims"[6,7] of the health care system's deficiencies. In contrast, although postoperative deaths from CABG occur about 5 times as often as preoperative deaths among those in the queue, physicians and families alike can take comfort in the fact that "everything possible was done."

The preoperative death rate could be reduced by shortening waiting times, if only because fewer people would be in the queue for shorter periods. However, for any period of observation, some deaths are to be expected among older people with ischemic heart disease, who constitute the majority of those accepted for CABG worldwide. The true incremental risk of delayed versus immediate CABG can therefore be determined only through a randomized trial with long-term follow-up. Historical trials comparing CABG and medical therapy offer somewhat analogous experiments, because many patients in the medical arm crossed over to CABG when their symptoms worsened.[8] However, there are limitations to the inferences that can be drawn from these trials.[8]

In our study we explored an alternative method for benchmarking the vital risk of waiting for CABG.

Research

Recherche

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Methods

To benchmark the vital risk we first related the observed death rate among consecutive patients awaiting CABG in Ontario (excluding those who underwent emergency CABG) to the expected death rate among people in the general population matched by age and sex and observed for the same period — an actuarial measure known as the "standardized mortality ratio." We then calculated the standardized mortality ratio for people of the same age and sex in Ontario who were admitted to hospital 6 months earlier because of an acute myocardial infarction (AMI) but who were not in the queue for CABG. By comparing the vital risks in these 2 groups of patients, we could determine whether those in line for CABG were dying more frequently than would be expected given not only the population's time under observation but also the presence of significant coronary artery disease in all subjects.

Patients awaiting CABG

As of October 1991 all patients in Ontario registered for cardiac surgery in the province are entered into the Cardiac Care Network of Ontario registry, which tracks patients while they await surgery.[4] The waiting period begins when the patient is accepted for surgery by a cardiac surgeon. The registry captures all patients, including inpatients requiring urgent surgery after cardiac catheterization. Only people receiving emergency surgery on the same day as cardiac catheterization are excluded. Data are collected from patient interviews and health records by dedicated personnel and are validated periodically through random chart audits; agreement for major variables exceeds 97%. Data are transmitted regularly for compilation and further validation at a central source.

We limited our analysis to patients awaiting isolated CABG, who account for 84% of all people undergoing open-heart procedures in Ontario. We examined registry data for consecutive patients in queue from October 1991 to February 1996. We excluded those who were still waiting at the end of this period or who were removed from the queue for reasons other than completion of surgery or death (e.g., a decision to switch to medical therapy or undergo angioplasty). We also excluded obvious duplicate cases and those with internal date inconsistencies that might lead to potential errors in the calculation of waiting times.

The timeframe for our analysis was determined by converting the database into a time-series format (i.e., transecting the patient queue weekly). Graphical examination permitted determination of the period during which the numbers of patients entering and leaving the queue were more or less equivalent. This period was a 198-week window from Nov. 25, 1991, to Sept. 10, 1995, during which 21 830 potentially eligible patients underwent isolated CABG. We excluded 73 patients whose recorded date of birth was incomplete (e.g., date, month or year was missing), as this information was required for calculation of standardized mortality ratios. Finally, to mitigate outlier influences and date-of-birth errors caused by data-entry mistakes, we trimmed the top and bottom outliers from the age range, excluding a further 181 patients. This left 21 576 patients awaiting CABG whose ages ranged from 33 to 81 years.

Patients with acute myocardial infarction

To compile the comparison group of patients living with coronary artery disease, we used discharge abstract data from the Canadian Institute for Health Information. Patients with a primary discharge diagnosis of AMI (International Classification of Diseases code 410) were selected for 3 fiscal years, or 156 weeks, covering the period Apr. 1, 1991, to Mar. 31, 1994. For any patient who had multiple AMIs in the 3-year period, the last recorded admission was taken as the incident event for follow-up. We excluded patients discharged within 4 days of admission because we felt that they probably had chest pain without confirmed AMI, including unstable angina. To avoid double-counting patients who were waiting for CABG, we excluded patients who underwent either CABG or percutaneous transluminal coronary angioplasty within 12 months of the index admission (about 15% of those admitted to hospital because of an AMI). This left 36 715 potentially eligible cases. Because about two-thirds of the cumulative 1-year mortality from AMI occurs in the first few days after admission and because the mortality rate falls steadily over the next several weeks and plateaus within about 6 months of the index admission,[9] we included only patients who survived for the first 6 months and we started follow-up 180 days after the index admission. We therefore excluded 2542 patients who died in the first 6 months. Another 3702 patients were excluded: 3697 because they were outside the age range established for CABG (33–81 years) and 5 because of incomplete date-of-birth information. A total of 30 471 patients remained for analysis. Because few of the patients in the CABG queue waited more than several months, we truncated the follow-up of patients in the comparison group at 12 months after admission (i.e., a maximum of 185 days at risk for those who survived the entire period). We collected data on each patient's date of birth, sex, date of index admission, and occurrence and date of death in the period from 180 to 365 days after admission as ascertained from Ontario's Registered Persons Database.

Analysis

We matched the 30 471 AMI patients by age and sex to the 21 576 CABG patients, randomly selecting AMI patients when more than one met the matching criteria. After excluding CABG patients who could not be matched, we were left with 21 220 patients in each group. We included deaths from all causes in both cohorts.

We calculated the expected mortality for both patient groups using the 1990–1992 Ontario life tables published by Statistics Canada.[10] For each patient's number of days at risk, the age- and sex-specific daily probability of dying was cumulated, incorporating any discrete changes in expected mortality that were due to birthdays while under observation. The summation of all these individual probabilities of death represents the number of deaths expected in an equivalent (matched for age, sex and days under observation) sample of Ontarians. The standardized mortality ratio was calculated by dividing the actual number of observed deaths by the expected number of deaths. Confidence intervals (CIs) around the ratio were constructed using the method suggested by Rosner.[11]

Because median follow-up times were much shorter for the patients awaiting CABG than for those in the post-AMI cohort, we undertook a sensitivity analysis to determine how the standardized mortality ratio in the post-AMI cohort varied with shorter follow-up times. Relative stability of the standardized mortality ratios starting at 6 months would also confirm that these survivors had passed the period of sharply increased vital risk associated with the index AMI.

Additional statistical comparisons involving these groups of patients were undertaken with *t*-tests and χ^2 tests of independence.

Results

The matched demographic profiles of the 2 groups are shown in Table 1. The median waiting time in the CABG group was 18 days (interquartile range 5–56 days). There were 82 deaths. The standardized mortality ratio for the CABG cohort was 2.92 (95% CI 2.29–3.55). In the post-AMI cohort the median follow-up was 185 days, without variability except for the 663 patients who died between days 181 and 365. The standardized mortality ratio in the AMI group was 3.84 (95% CI 3.54–4.14).

In the sensitivity analysis for different lengths of follow-up of the post-AMI cohort, the vital risk was essentially unchanged as the length of follow-up from the index admission was reduced (Fig. 1). This analysis indicated that, 6 months after an AMI, this patient population had a reasonably stable hazard rate.

Interpretation

Our analysis demonstrated that patients awaiting CABG were almost 3 times more likely to die than members of the general population of the same age and sex. However, the vital risk among patients awaiting CABG was lower than that among age- and sex-matched patients who survived at least 6 months after admission to hospital with an AMI. The post-AMI patients had a fairly constant hazard rate, which was about 4 times higher than the general population over a 6-month follow-up period.

The Cardiac Care Network of Ontario registry captures all patients except those who move immediately from angiography to surgery on an emergency basis. Deaths in the queue are tracked meticulously, and the accuracy of the registry data has been audited with favourable results. Thus, underestimation of deaths in the queue is unlikely to account for our findings.

We excluded patients from the post-AMI cohort who underwent angioplasty or CABG. Those who underwent angioplasty likely had limited coronary disease, but their numbers were relatively small. Cumulative 1-year rates of angioplasty in the post-AMI cohort rose from 6.5% among patients admitted to hospital in calendar year 1991 to 7.4% among those admitted in 1994. Including the slightly larger proportion of post-AMI patients who underwent CABG would have resulted in our counting some patients twice. It is true that the CABG population would be selected to exclude patients with serious comorbidity, inoperable coronary disease and irreparably damaged left ventricles. However, we have previously shown that 93% of patients awaiting CABG in Ontario have significant coronary disease, defined as left main-stem stenosis, triple-vessel disease or double-vessel disease with a lesion in the proximal left anterior descending artery.[4] About 80% of patients in line for surgery have Canadian Cardiovascular Society class III or IV angina.[4,5] In contrast, the post-AMI cohort must have included a large number of patients whose symptoms were controlled with medical therapy or who had negative or low-risk findings on noninvasive tests for reversible ischemia. Thus, biases in the construction of the cohorts are unlikely to explain our findings.

A more fundamental criticism arises from the possibility that the comparison cohort was inappropriate a priori. We matched the cohorts by age and sex, and all subjects in both groups had significant coronary disease. However, retrospective linkage of data for patients undergoing CABG in Ontario during the study period showed that only about 35% had been admitted to hospital with an AMI some time

Table 1: Characteristics and standardized mortality ratios of patients waiting for CABG and those surviving 6 months after AMI in Ontario, matched by age and sex

Variable	Patients waiting for CABG *n* = 21 220	Post-AMI patients *n* = 21 220
Mean age (and SD), yr	61.9 (9.5)	61.9 (9.5)
% (and no.) female	21.6 (4,578)	21.6 (4,578)
Median days under observation (and IQR)	18 (5–56)	185 (185–185*)
Total no. of deaths expected	28.08	164.77
Total no. of deaths observed	82	663
Standardized mortality ratio (and 95% CI)	2.92 (2.29–3.55)	3.84 (3.54–4.14)

Note: CABG = coronary artery bypass grafting, AMI = acute myocardial infarction, SD = standard deviation, IQR = interquartile range, CI = confidence interval.
*Maximum total follow-up from day of admission was 365 days. Starting follow-up at 180 days (6-month survivors), this led to a median 185-day follow-up period, with variation only in the case of deaths.

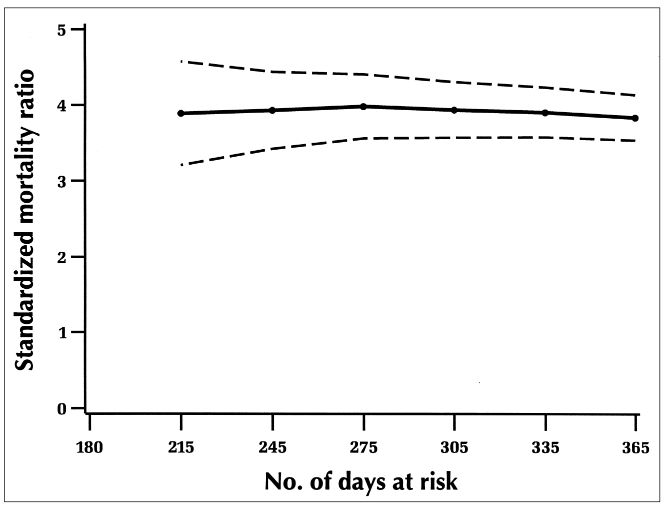

Fig. 1: Standardized mortality ratios in relation to days at risk among 21 220 people from 6 months to 1 year after admission to hospital because of acute myocardial infarction. Standardized mortality ratios and related 95% confidence intervals (dotted lines) are shown for approximately 1-month increments in follow-up periods.

in the preceding 4 years.[12] In contrast, we included only post-AMI patients in the comparison cohort. The comparison falls short of the ideal that would be achieved by randomly assigning patients to accelerated CABG or to usual queuing practices. However, although the comparison population is not representative of those living with angina who have never had an AMI, it is certainly representative of tens of thousands of people who have clinically significant coronary artery disease and who, in most instances, can be considered as having stable coronary artery disease several months after hospital admission with an AMI.

A general study limitation is the fact that death is not the only adverse outcome of waiting for CABG. In about 5% of cases the patient's condition deteriorates and urgent admission for CABG is required. These patients incur slightly increased perioperative risk because surgery is undertaken on an urgent basis in the face of refractory unstable angina. As well, our analyses shed no light on delayed relief of symptoms or medication side effects, and the associated quality-of-life burdens resulting from waiting for coronary surgery. This point is pertinent given the moderate to severe chest pain documented for most patients in queues in Ontario[4] and other provinces.[13,14] Moreover, many patients in the queue are fearful that they will die or have a myocardial infarction while waiting.[15] Such psychological burdens have received limited attention, but along with potential economic burdens from changes in job status they must be considered in any discussion of maximal queue lengths.[1]

A final limitation is the fact that we focused only on the waiting time from the booking of CABG after angiography. Some patients die while waiting for cardiology consultations and coronary angiography.[16,17]

Why was the standardized mortality ratio for patients awaiting CABG lower than that for age- and sex-matched control subjects who survived 6 months after hospital admission for an AMI? There may have been clinical differences in the characteristics of these 2 cohorts, but differences in treatment or surveillance may also have played a role. There is evidence to indicate that the quality of acute and post-discharge care of patients surviving an AMI varies across hospitals and regions of Ontario.[18,19] In contrast, Ontario has strictly regionalized tertiary cardiac services.[20] All patients in the queue for CABG have therefore been seen in consultation by an experienced cardiologist and cardiac surgeon. Most centres also maintain regular telephone follow-up with patients on waiting lists to ensure rapid changes in medication or accelerated surgery if symptoms worsen. A related influence on the risk of death is the widespread adoption of queuing criteria in Ontario, which were derived with reference to mortality outcomes in randomized trials of CABG versus medical therapy.[4,8,21] The goal of the Ontario queuing system has been to match relative waiting times to the relative risk of death and symptomatic burden arising from delayed revascularization. By complying with these criteria, and ensuring that high-risk patients undergo expedited revascularization, Ontario's cardiovascular specialists have apparently constrained the risk faced by patients awaiting CABG.[4,5]

In conclusion, we have presented a novel method for benchmarking the burden of waiting lists. With a well-organized and evidence-based queuing system, the risk of death among patients waiting for CABG is not disproportionate to the risk among thousands of others living with coronary artery disease. However, no benchmark for deaths in the queue for cardiac surgery can ever measure the private grief of families who perceive that the health care system has failed them, or the frustration of professionals faced with simultaneously caring for patients and managing scarce services. Given the ubiquity of waiting lists and the competing demands on health care resources, this type of comparative analysis may at least help to put these disturbing events into perspective.

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