JACC Vol. 27, No. 6
May 1996:1365–73

Managed Delay for Coronary Artery Bypass Graft Surgery: The Experience at One Canadian Center

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Objectives. **This study sought to assess the impact of delaying coronary artery bypass surgery at one Canadian academic tertiary referral center.**

Background. **Universal access to medical services in Canada comes at the expense of waiting lists whose impact has been incompletely assessed.**

Methods. **A prospective, observational study of all residents of Nova Scotia and Prince Edward Island accepted for bypass surgery between 1 April 1992 and 31 October 1992 was undertaken to determine 1) whether triage guidelines were being followed; and 2) the incidence of cardiac death, nonfatal myocardial infarction and worsening symptoms associated with delayed operation. The analysis had 90% power to detect a mortality rate of ≥3% (alpha 0.05).**

Results. **Of 423 patients referred, 35% were triaged as urgent, 9.7% as semiurgent A, 39% as semiurgent B and 16.3% as elective, with no age or gender bias identified. Operation occurred at ≤1 week in 25%, ≤1 month in 47%, and >6 months in 1.4%. There were no nonfatal myocardial infarctions, but five cardiac deaths occurred (1.2%). Of 275 patients not initially classified as urgent, 12.4% required reclassification to higher priorities because of worsening symptoms: none had perioperative myocardial infarction or died. One in four patients queued longer than target waiting times. Only 4% of patients considered prioritization on the basis of medical need unfair, but 64% experienced at least moderate anxiety.**

Conclusions. **This triage system equitably stratified patients to a queue. Deaths were rare and could not be attributed to the triage process. Patients with worsening clinical status were safely accommodated with earlier waiting times, but concerns remain regarding excessive waiting times and patient anxiety.**

(J Am Coll Cardiol 1996;27:1365–73)

As Americans consider health care reform, the Canadian model has come under increased scrutiny (1–3). Universal access is offered in Canada, but at the expense of long waiting lists (4–8). Whereas patients requiring urgent surgery are managed promptly, limited resources dictate that nonurgent patients must wait varying lengths of time for their operation. Such delay of medical services is defensible only if the process used is safe and fair (9).

Delayed coronary artery bypass graft surgery in Canada has generated debate about budget limits and health care needs (10–16). In 1988 and 1989, a dramatic increase in referrals for bypass surgery overwhelmed surgical capacity (17). Patients waited a mean of 22.6 weeks for elective surgery (18), and some died. Uncoordinated referral and inconsistent approaches to prioritizing patients aggravated the situation (4,19,20). Cardiac surgical centers responded by developing rational systems for assessing patient priority similar to triage guidelines published in 1990 by a consensus panel (21). Nonetheless, concerns persist because critical evaluation of the safety and fairness of queuing is only lately being done (22,23). Both a recent international comparison of waiting times (24) and its accompanying editorial (25) stressed the need for more outcomes data.

Canadian patients wait for specialist assessment, angiography, referral to surgery and finally for availability of surgical facilities. The care before surgical referral remains largely discretionary, and data regarding its process and outcomes are limited. In practice, however, the true surgical delay extends from the decision to proceed with surgery until the operation. We undertook a prospective outcomes assessment of the system used to prioritize patients for bypass surgery following surgical referral at one Canadian cardiovascular center. Specifically, we sought to establish whether our triage system was safe and equitable in terms of patients in fact being triaged according to explicit criteria of medical need. Further, we aimed to determine whether local targets for surgical delays were being met.

Methods

Patient triage process. The Victoria General is a teaching hospital of Dalhousie University, Halifax, Nova Scotia. It is the

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Manuscript received October 12, 1995; revised manuscript received December 31, 1995, accepted January 9, 1996.

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0735-1097/96/$15.00
PII S0735-1097(96)00028-9

JACC Vol. 27, No. 6
May 1996:1365–73

sole provider of cardiovascular surgery to the Provinces of Nova Scotia and Prince Edward Island, a population of roughly one million persons. Six cardiovascular surgeons perform approximately 1000 coronary bypass procedures each year.

Halifax is the only center in Canada where all patients requiring revascularization within two provinces are reviewed at a single, centralized cardiovascular conference. This provides a unique opportunity to assess the triage process. Patients are presented, reviewed evaluated, prioritized and scheduled for surgery based on consensus opinion. Patients cannot circumvent this system except by having surgery done outside of Nova Scotia, and, because there is no mechanism for outside referral, this occurrence is rare.

All patients referred for bypass surgery are stratified, according to a four-tiered urgency-ranking scheme, by consensus at a weekly conference of cardiovascular specialists that functions as an instrument of peer review. Explicit guidelines (see Appendix) are used to assess the suitability and relative urgency of surgery among all patients referred. Similar to organized referral systems elsewhere in Canada (21), the process takes into account symptom severity, coronary anatomy and functional status only.

In 1991, a task force, which included community-based primary care physicians as well as university-affiliated cardiovascular specialists, was asked to develop standards for access to various cardiovascular services in Nova Scotia. This body reported to the Metropolitan Hospital Advisory Committee and the Nova Scotia Department of Health. Because of evidence suggesting that half of patients ill for longer than 6 months may fail to return to work (26), the task force recommended that 6 months be set as the maximum elective delay for cardiac catheterization and surgery combined. Accordingly, target waiting times are within a week of prioritization for urgent patients who remain in hospital until their operative date, 2 to 4 weeks for semiurgent A patients, 4 to 10 weeks for those ranked semiurgent B, and 10 to 16 weeks for elective patients.

Patients are generally assigned the first available surgeon. Requests for specific surgeons are accommodated where possible, but patients are given to understand that this may lengthen their waiting time. If a patient is deemed by the attending cardiologist to warrant earlier surgery, usually because of worsening symptoms, then the data in support of reclassification are reviewed at a subsequent cardiovascular conference. The decision to reclassify and the revised priority ranking are again established by consensus.

Study population. The hospital's Research Review Committee approved prospective follow-up of consecutive patients referred for isolated bypass surgery from April 1, 1992 to October 31, 1992. Surgical delays were defined as the time from priority assignment at the surgical conference to surgery. The four outcomes of interest were surgery as scheduled, cardiac death (defined clinically as fatal myocardial infarction, documented arrhythmic death or sudden death without a noncardiac etiology), nonfatal myocardial infarction (defined as any two of characteristic symptoms, electrocardiographic changes or cardiac enzyme rise), and patient reclassification to a more urgent category because of a change in clinical status.

Patients undergoing cardiovascular surgery that did not involve bypass grafting, or in whom bypass grafting was undertaken in conjunction with another procedure, such as valve replacement, were excluded. The intent was to ensure comparability between patients by eliminating pathologies with potentially confounding influences on prioritization and outcomes.

Data acquisition and entry. After providing informed consent, patients were surveyed at the time of cardiac catheterization (generally occurring within a week of discussion at conference) regarding a variety of demographic and baseline clinical data, including employment status, symptom severity, history of prior cardiac events and comorbid ailments. Symptoms were appraised using a modified Canadian Cardiovascular Society angina classification scheme (21), which enables specific assessment of unstable angina. Under this scheme, class IVa refers to unstable angina resolving with oral therapy, class IVb refers to unstable angina resolving partly with oral therapy but returning with minimal provocation, and class IVc refers to unstable angina requiring parenteral or mechanical intervention, such as intraaortic balloon support. In addition, a simple patient disability score was employed that queried whether individuals experienced "no," "mild," "moderate" or "severe limitation of desired activities" (27).

Chart abstraction was used to obtain information about medications, extent of coronary artery disease and ejection fraction. Information was collected concerning any interim hospitalization, occurring anywhere, including the number of days spent in intensive and nonintensive care beds. The operative record was reviewed to identify all perioperative deaths and myocardial infarctions. Cases where waiting resulted in unstable symptoms, and hence higher operative risks, were investigated because perioperative death in such circumstances might be attributed to delayed surgery. If a patient failed to appear for surgery, the referring or family physician was contacted to establish the reason for the absence. In rare instances, obtaining this information required contacting the patient's family.

The charts on all patients who died awaiting surgery, all patients reclassified because of worsening symptoms and 50 randomly selected cases were independently reabstracted and data reentered into computer to ensure integrity.

Patient satisfaction and concerns. A subgroup of 100 consecutive, nonemergency patients consented to an interviewer-administered questionnaire during their surgical admission. Three issues were examined: 1) the level of anxiety attributable to the surgical waiting time, rated as "none," "mild," "moderate" or "severe"; 2) whether waiting provoked anger, and whether being queued on the basis of medical need was perceived as unfair; and 3) whether delayed surgery resulted in economic hardship.

Data analysis. All data were expressed as means with standard deviations or as counts with proportions. Comparison of means was by unpaired *t* test or analysis of variance.

Categoric variables were analyzed using the chi-square statistic or, where cell counts were low, Fisher's exact test. Logistic regression was used to study the relation between patient variables and the outcomes of interest. The models included a number of prespecified variables hypothesized to relate to outcome, namely, all cardiac risk factors, history of prior myocardial infarction or congestive heart failure, Canadian Cardiovascular Society symptom classification, ejection fraction, left mainstem disease, proximal left anterior descending coronary artery disease and three-vessel coronary artery disease. Also considered were any additional variables associated with outcome on univariate analysis at a significance level of $p < 0.05$. Finally, prior experience (23) suggested that waiting lists for bypass surgery in Canada are associated with approximately a 1% mortality. Because the perioperative mortality in our center is less than 3%, a waiting list mortality of 3% or greater was deemed unacceptable. To detect a mortality rate this high with 90% power mandated a minimum sample size of 390 patients (one-tail test at the alpha = 0.05 level of significance).

Results

Patient population, waiting times and urgency ratings. There were 429 consecutive patients referred for isolated coronary artery bypass surgery during the study period. Six patients dropped out of the queue: one was canceled by the referring physician, two declined surgery themselves, two underwent surgery out of province and one died of metastatic colon cancer that had not been detected at the time of referral. The remaining 423 (98.6%) patients continued to one of the prespecified outcomes. Of these, 148 (35%) were classified urgent, 41 (9.7%) semiurgent A, 165 (39%) semiurgent B and 69 (16.3%) elective.

Patient characteristics. Patient characteristics are listed in Table 1, stratified according to priority ranking. The mean age was 64.2 years (ranging from 31 to 88 years). Just over one quarter of all patients were female. There was an unexplained tendency for retired patients and homemakers to be triaged more urgently.

Consistent with the criteria for prioritization, patients ranked urgent were most symptomatic. No differences were noted in symptom burden among those in the other three categories, reflecting the relatively greater influence of anatomy and functional capacity on triage decisions in these groups. Four patients with unstable angina were Canadian Cardiovascular Society class IVc at the time of cardiac catheterization but improved sufficiently to be triaged to nonurgent categories.

Patients manifesting a prior history of congestive heart failure received greater priority. There was also a trend for urgent patients to have had a prior myocardial infarction. The proportion of patients having specific cardiac risk factors did not differ across priority categories.

Medical therapy. Patients ranked urgent more likely received intravenous drugs (heparin and/or nitroglycerin) and required hemodynamic support with an intraaortic balloon pump (Table 2). They also received more angiotensin-converting enzyme inhibitors and, indeed, more drugs of any kind. Nine patients who initially required intravenous medications for unstable angina nevertheless stabilized and were triaged to less urgent rankings. In all, 61.7% of study patients were managed with triple antianginal therapy (at least one each of nitrate, calcium channel blocker, and beta-adrenergic blocker), distributed as follows: urgent, 71.6%; semiurgent A, 51.2%; semiurgent B, 53.9%, and elective, 65.2% ($p = 0.0055$). Including aspirin, taken by 98.1% (no difference across strata), a median number of four drug classes were prescribed per patient.

Angiographic results. Most patients had three-vessel coronary artery disease (Table 3). As expected, severe (≥50% lumen narrowing) left mainstem disease was significantly more common among patients in the urgent and semiurgent A categories. Five patients with left mainstem disease had minimal symptoms and excellent functional capacity and so were assigned to elective surgery. Severe (≥70% lumen narrowing) left anterior descending disease was most prevalent among patients in the urgent and semiurgent B categories but ceased to be statistically significant when only disease in the proximal third of the artery was considered. The distribution of angiographically determined mean ejection fractions varied across rankings. Specifically, elective patients had better left ventricular function than those ranked urgent ($p = 0.0003$). The ejection fraction was 40% or less in 30 (7.2%) patients and 50% or less in 73 (17.4%) patients.

Patient outcomes. The mean surgical delay from prioritization was 62.3 ± 13.6 days. Patients triaged as urgent waited a mean of 2.8 ± 3.7 days, semiurgent A a mean of 19.2 ± 7.0 days, semiurgent B a mean of 60.6 ± 19.4 days and elective patients a mean of 122.0 ± 38.8 days.

Of the 384 (91%) patients operated on as scheduled according to their relative urgency rankings, 27.6% had surgery within 1 week, 47.4% within 4 weeks, and only 1.6% waited longer than 24 weeks (Table 4). All urgent patients had surgery within 2 weeks. A single outlier ranked semiurgent B waited beyond 24 weeks because of a protracted evaluation for carotid and renal artery disease. Although patients undergoing surgery according to schedule were least likely to have sustained a prior myocardial infarction ($p = 0.028$), no patient variables predicted stability in the queue on multivariate analysis, even when performed by separate stratification category.

No patient sustained a nonfatal myocardial infarction. Five patients died suddenly of cardiac causes, at 1, 2, 8, 9 and 27 days after assignment of an urgency ranking and were equally distributed across the four priority strata (Table 5). As compared to patients whose surgery was as scheduled or reclassified, they more likely had a prior myocardial infarction (100% vs. 56.8% and 73.5%, $p = 0.028$), lower mean ejection fraction (49.0 vs. 62.5 and 62.8, $p = 0.086$) and involvement of the left mainstem coronary artery (40% vs. 5.2% and 2.9%, $p = 0.002$). In addition, all were male, and all had three-vessel coronary

Table 1. Patient Demographic and Clinical Characteristics

	Total (n = 423)	Surgical Waitlist Category				p Value
		Urgent (n = 148)	Semi-A (n = 41)	Semi-B (n = 165)	Elective (n = 69)	
Mean age (SD)	64.2 (10.3)	65.1 (10.1)	65.1 (10.8)	63.9 (10.3)	62.1 (10.0)	0.218
Gender						
Male	304 (71.9%)	105 (71.0%)	29 (70.7%)	116 (69.9%)	54 (79.4%)	
Female	119 (28.1%)	43 (29.1%)	12 (29.3%)	50 (30.1%)	14 (20.6%)	0.507
Employment						
Employed	82 (19.4%)	19 (12.8%)	6 (14.6%)	41 (24.7%)	16 (23.5%)	
Unemployed	8 (1.9%)	5 (3.4%)	0 (0.0%)	2 (1.2%)	1 (1.5%)	
Unable to work	26 (6.1%)	4 (2.7%)	2 (4.9%)	11 (6.6%)	9 (13.2%)	
Retired	236 (55.8%)	93 (62.8%)	23 (56.1%)	87 (52.4%)	33 (48.5%)	
Homemaker	71 (16.8%)	27 (18.2%)	10 (24.4%)	25 (15.1%)	9 (13.2%)	0.013
CCS score						
I	6 (1.4%)	1 (0.7%)	0 (0.0%)	4 (2.4%)	1 (1.5%)	
II	31 (7.3%)	5 (3.4%)	6 (14.6%)	9 (5.4%)	11 (16.2%)	
III	235 (55.6%)	49 (33.1%)	27 (65.9%)	112 (67.5%)	47 (69.1%)	
IVa	61 (14.4%)	24 (16.2%)	3 (7.3%)	26 (15.7%)	8 (11.8%)	
IVb	28 (6.6%)	11 (7.4%)	4 (9.8%)	12 (7.2%)	1 (1.5%)	
IVc	62 (14.7%)	58 (39.2%)	1 (2.4%)	3 (1.8%)	0 (0.0%)	< 0.0001
Disability score						
1	5 (1.2%)	0 (0.0%)	0 (0.0%)	2 (1.2%)	3 (4.4%)	
2	51 (12.1%)	7 (4.7%)	7 (17.1%)	24 (14.5%)	13 (19.1%)	
3	210 (49.7%)	50 (33.8%)	23 (56.1%)	98 (59.0%)	39 (57.4%)	
4	157 (37.1%)	91 (61.5%)	11 (26.8%)	42 (25.3%)	13 (19.1%)	< 0.0001
Prior history of						
MI	248 (58.6%)	98 (66.2%)	20 (48.8%)	95 (57.2%)	35 (51.5%)	0.081
PTCA	60 (14.2%)	23 (15.5%)	7 (17.1%)	16 (9.6%)	14 (20.6%)	0.132
CABG	38 (9.0%)	13 (8.8%)	5 (12.2%)	11 (6.6%)	9 (13.2%)	0.368
CHF	58 (13.7%)	34 (25.0%)	7 (17.1%)	15 (9.0%)	2 (2.9%)	< 0.0001
Risk factors						
DM	96 (22.7%)	35 (23.7%)	8 (19.5%)	38 (22.9%)	15 (22.1%)	0.954
Chol	166 (39.3%)	57 (38.5%)	18 (45.0%)	66 (39.8%)	25 (36.8%)	0.854
FamHx	273 (64.5%)	96 (64.9%)	29 (70.7%)	101 (60.8%)	47 (69.1%)	0.511
Smoker						
Prior	230 (54.4%)	75 (50.7%)	25 (61.0%)	92 (55.4%)	38 (55.9%)	
Current	69 (16.3%)	21 (14.2%)	4 (9.8%)	34 (20.5%)	10 (14.7%)	0.287
HTN	223 (52.7%)	80 (54.1%)	21 (51.2%)	88 (53.0%)	34 (50.0%)	0.950

Symptom grades as well as a history of congestive heart failure (CHF), diabetes mellitus (DM), hypercholesterolemia (Chol), family history of premature coronary artery disease (FamHx) or hypertension (HTN) are as given by the referring cardiologist, who must submit any and all such information, with laboratory values as appropriate, at the surgical conference. Numbers in parentheses are standard deviations for continuous variables or proportions for categoric variables. Proportions may not add to 100% because of rounding. CABG = coronary artery bypass grafting; CCS = Canadian Cardiovascular Society; MI = myocardial infarction; PTCA = percutaneous transluminal coronary angioplasty; Semi-A, Semi-B = semiurgent A, semiurgent B, respectively.

artery disease. The number of deaths was too small for meaningful multivariate analysis.

Of 275 patients not initially classified urgent, 34 (12.4%) required reclassification to a more urgent surgical category after developing unstable symptoms (Table 4), with no difference across strata (p = 0.64). All were stabilized and accommodated with an earlier surgical date, and none died or experienced a perioperative myocardial infarction during their surgical admission. Although there were 11 perioperative deaths, these occurred uniformly among patients whose operations took place according to schedule (Table 5). Reclassified patients had the lowest prevalence of left mainstem disease (2.9%) and a rate of three-vessel disease similar to that of patients undergoing surgery as scheduled (64.7% vs. 64.3%). The only predictor of reclassification following multivariate analysis was a history of being in Canadian Cardiovascular Society class IVb or IVc at coronary angiography (odds ratio 8.71; 95% confidence intervals 3.36 to 22.62; p = 0.0001). Rehospitalization was required by 37 patients (29 of whom were also reclassified), 4 (9.5%) semiurgent A, 23 (13.9%) semiurgent B and 10 (14.5%) elective, who together accounted for 119 intensive care bed days and 366 non–intensive care bed days.

Patient satisfaction and concerns. The 100 patients who answered our questionnaire were comparable to the overall study population except for their distribution across priority rankings (16% urgent, 8% semiurgent A, 43% semiurgent B and 33% elective). Thus, proportionately more elective pa-

Table 2. Patient Medical Therapy at the Time of Assignment of Surgical Waitlist Category

	Total (n = 423)	Surgical Waitlist Category				p Value
		Urgent (n = 148)	Semi-A (n = 41)	Semi-B (n = 165)	Elective (n = 69)	
Intensive therapy						
IV/IM	128 (30.3)	88 (59.5)	5 (12.2)	26 (15.7)	9 (13.2)	< 0.0001
IABP	19 (4.5)	19 (12.8)	0 (0.0)	0 (0.0)	0 (0.0)	< 0.0001
Drug categories						
ASA	415 (98.1)	142 (96.0)	41 (100.0)	164 (98.8)	68 (100.0)	0.100
NTG	398 (94.1)	141 (95.3)	39 (95.1)	154 (92.1)	64 (94.1)	0.809
Ca	346 (81.8)	129 (87.2)	33 (80.5)	129 (77.7)	55 (80.9)	0.186
BB	312 (73.8)	110 (74.3)	29 (70.7)	115 (69.3)	58 (85.3)	0.085
Heparin	133 (31.4)	92 (62.2)	5 (12.2)	27 (16.3)	9 (13.2)	< 0.0001
Warfarin	15 (3.6)	7 (4.7)	3 (7.3)	5 (3.0)	0 (0.0)	0.176
ACEI	86 (20.3)	36 (24.3)	14 (34.2)	33 (19.9)	3 (4.4)	0.001

Numbers in parentheses are standard deviations for continuous variables or proportions for categoric variables. Proportions may not add to 100% because of rounding. ACEI = angiotensin-converting enzyme inhibitors; ASA = aspirin; BB = beta-blockers; Ca = calcium channel blockers; IABP = intraaortic balloon pump; IM = intramuscular; IV = intravenous; NTG = nitrates; other abbreviations as in Table 1.

tients, whose longer delays would more likely provoke dissatisfaction, were sampled. Although 16% expressed no anxiety consequent to their waiting time, 64% registered at least moderate anxiety (no difference across rankings, p = 0.980). Anxiety was greater among younger patients as compared to those older than 60 years of age (p = 0.020). While 16% of patients expressed anger with having their surgery delayed, only 4% felt that queuing patients according to medical need was unfair.

Economic hardship, attributed directly to delayed surgery, was declared by 15% of those surveyed. This primarily affected younger individuals, those still working, and patients in "blue collar" (manual labor) occupations (Table 6).

Discussion

The benefits of coronary artery bypass surgery in the management of ischemic heart disease have been well established (28). However, the inherent tension within the Canadian health care system between the promise of universality of care and the finite nature of medical resources has led to managed delays for such therapy. Published data on queue management and outcomes are minimal. Recent work suggesting that waiting times for bypass surgery in Canada remain excessive (29) emphasizes the need for such data.

The context of the present study. Two recent Canadian studies have begun to shed light on this issue (22,23). Carrier

Table 3. Patient Angiographic Information*

	Total (n = 423)	Surgical Waitlist Category				p Value
		Urgent (n = 148)	Semi-A (n = 41)	Semi-B (n = 165)	Elective (n = 69)	
Number of diseased arteries						
One	29 (6.9%)	8 (5.4%)	1 (2.4%)	14 (8.5%)	6 (8.7%)	
Two	111 (26.2%)	35 (23.6%)	13 (31.7%)	43 (26.1%)	20 (29.0%)	
Three or more	283 (66.9%)	105 (71.0%)	27 (65.8%)	108 (65.4%)	43 (62.3%)	0.175
Diseased artery						
LMCA	89 (21.0%)	35 (23.7%)	16 (39.0%)	33 (19.9%)	5 (7.4%)	0.001
LAD	374 (88.4%)	137 (92.6%)	33 (80.5%)	149 (89.8%)	55 (80.9%)	0.028
Cx	323 (76.4%)	112 (75.7%)	31 (75.6%)	125 (75.3%)	55 (80.9%)	0.819
RCA	350 (82.7%)	127 (85.8%)	33 (80.5%)	133 (80.1%)	57 (83.8%)	0.577
Proximally diseased artery						
LAD	360 (85.1%)	131 (88.5%)	33 (80.5%)	142 (85.5%)	54 (79.4%)	0.283
Cx	306 (72.3%)	107 (72.3%)	28 (68.3%)	119 (71.7%)	52 (76.5%)	0.813
RCA	306 (72.3%)	113 (76.4%)	29 (70.7%)	116 (69.9%)	48 (70.6%)	0.604
Mean EF	62.3 (13.6)	59.6 (14.6)	62.0 (16.6)	62.9 (12.5)	66.9 (10.4)	0.003

*Only coronary arteries having ≥70% lumen narrowing, or ≥50% if left main (LMCA), are tabulated. Numbers in parentheses are proportions for categoric variables or mean value with standard deviation for continuous variables. Proportions may not add to 100% because of rounding. Cx = circumflex; EF = ejection fraction (could be obtained angiographically for only 419 patients); LAD = left anterior descending; RCA = right coronary artery; other abbreviations as in Table 1.

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Table 4. Time to Operation for 418 Surviving Patients, Stratified by Original Priority Ranking

	Waiting Time (weeks)						
	≤1	>1–2	>2–4	>4–10	>10–16	>16–24	>24
Operation as scheduled (n = 384)							
Urgent	106	41	0	0	0	0	0
Semiurgent A	0	5	28	3	0	0	0
Semiurgent B	0	1	1	94	48	0	1
Elective	0	0	0	4	11	36	5
Operation moved forward (n = 34)							
Urgent*	—	—	—	—	—	—	—
Semiurgent A	0	1	3	0	0	0	0
Semiurgent B	0	1	7	10	1	0	0
Elective	0	0	1	0	7	2	1

*By definition, urgent patients are not capable of further upgrade in priority ranking. Urgent = <2 weeks; Semiurgent A = within 2 to 4 weeks; Semiurgent B = within 4 to 10 weeks; Elective = within 10 to 16 weeks.

et al. (22) retrospectively analyzed patients referred to the Montreal Heart Institute and found no effect of surgical delay on perioperative events. Naylor et al. (23) showed that fatal and nonfatal myocardial infarctions occurred infrequently during the preoperative waiting period. However, their study was hampered by selection bias because a self-selected population of cardiologists referred only a portion of their patients to the Ontario provincial triage network from which their consecutive series was drawn.

The findings of the current study build on these previous observations by being prospective, more comprehensive and clinically detailed, and by describing the system in a different part of Canada. The availability of bypass surgery at only a single cardiovascular center in the study catchment area meant that all patients referred for surgery were included, and 99% of these were followed to an outcome. In addition to the previously investigated outcomes of interest, the number of patients requiring reclassification to a more urgent ranking because of deterioration in clinical symptoms was examined.

Shortcomings include the fact that our data represent the experience of only one Canadian center. However, because our prioritization guidelines and waiting times are comparable to those found elsewhere in Canada (29,30) (Table 7), our results should be broadly generalizable. More substantive is that we do not know what length of delay, if any, is appropriate. Although this important issue requires assessment, it was not the focus of our study. We did examine whether we at least met local waiting time targets.

Table 5. Select Characteristics of Patients Who Died

Patient No.	Gender	Age (yr)	Category	CAD	EF	CCS	Time to Death/Operation*
Died on wait list							
1	M	69	Elective	3 vessel	62	III	8 days
2	M	73	Urgent	LMCA, 3V	27	IVc	1 day
3	M	60	Semi-B	3 vessel	44	III	9 days
4	M	60	Semi-B	3 vessel	57	III	27 days
5	M	79	Semi-A	LMCA, 3V	55	III	2 days
Perioperative death							
1	M	68	Urgent	3 vessel	11	III	7 days
2	M	66	Semi-B	3 vessel	50	III	65 days
3	M	66	Urgent	2 vessel	62	IVc	1 day
4	M	67	Urgent	3 vessel	†	IVc	1 day
5	F	71	Urgent	3 vessel	73	IVa	1 day
6	M	72	Semi-B	1 vessel	55	III	64 days
7	M	75	Urgent	2 vessel	76	IVc	7 days
8	M	63	Semi-A	LMCA, 3V	61	III	25 days
9	M	76	Elective	3 vessel	78	IVa	109 days
10	M	64	Urgent	2 vessel	53	IVc	1 day
11	M	71	Urgent	LMCA, 2V	†	IVc	1 day

*Time from conference to death for patients who died on the waitlist and from conference to operation for perioperative deaths. Times are rounded *up* to the nearest whole day (i.e., deaths at "1 day" were <24 h). †Ejection fraction (EF) could not be measured angiographically. All patients who die perioperatively underwent operation as scheduled. CAD = coronary artery disease; CCS = Canadian Cardiovascular Society modified angina classification score (21,22) at time of conference; F = female; LMCA = left main; M = male; V = vessel.

Table 6. Perceived Economic Hardship According to Various Patient Strata

	Economic Hardship		
	Yes	No	p Value
Age (years)			
<50	7	8	
50–59	6	21	
60–69	2	30	
70–80+	0	26	< 0.0001
Employment status			
Not working	5	64	
Working as employee	8	16	
Self-employed	2	5	0.005
Worker type			
Blue collar	8	6	
White collar	2	15	0.018

Fairness and adherence to triage guidelines. An imperative of any system of managed delay is that it does not discriminate against specific patient groups or unjustly show preference to others. Our results show no evident age or gender bias in priority assignment for bypass surgery. If anything, elderly patients tended to undergo more urgent surgery. The study was not designed to identify bias in referral to surgery; however, this also appears unlikely. The mean age of 64.2 years among our patients is higher than reported in other Canadian (22,23,31) and American (32) studies. Although gender differences in revascularization rates have been documented elsewhere in Canada (33,34), our proportion of female patients queued for surgery (28.4%) was higher than at other Canadian centers (22,23). Importantly, the preponderance of patients with the most severe symptoms, patterns of coronary disease and left ventricular dysfunction in the more urgent categories affirmed that patients were being equitably prioritized according to medical need and hence consonant with the explicit guidelines on which our triage system was based. The finding that homemakers and retirees underwent earlier surgery may simply reflect confounding with age and greater burden of symptomatic disease. Many of our patients were elderly and hence retired, while older women still considered themselves active homemakers.

Table 7. Mean Waiting Times (weeks) for Cardiovascular Procedures*

	Study Area	Canada
General practitioner to specialist referral		
1993	4.0	4.2 (2.0–7.9)
Specialist referral to elective angiography		
1991	2.1	8.5 (2.1–12.2)
1993	4.4	4.4 (0.9–7.9)
Angiography to elective operation		
1991	25.9	21.3 (9.6–33.5)
1993	14.0	15.0 (7.9–28.0)

*Adapted from references 27 (1991 data) and 28 (1992 and 1993 data). Numbers in parentheses refer to the maximal and minimal waiting times across Canada.

Reasons for surgical referral. Patients are referred for surgery for a variety of reasons. As in other centers (25), most bypass procedures at the Victoria General Hospital are for symptom control. However, the higher rates of heart failure, antifailure medications, depressed ejection fractions and left mainstem disease among urgent patients suggest that prognostic concerns featured prominently.

The appropriateness of individual cases was not addressed. Others (35) have compared patients referred for bypass surgery in the provinces of Ontario and British Columbia to patients in New York State and have suggested that, at least by comparison to Americans, Canadian physicians are more conservative in their referral decisions, and the inappropriateness rate of procedures is consequently lower. There is no reason to suspect that this pattern is any different in Nova Scotia, where tertiary cardiovascular services are singularly regionalized. Drug dosages were not recorded, but if number of drugs is used to approximate intensity of medical therapy, then most patients were aggressively managed at the time of triage to surgery. The proportion of elective patients on triple antianginal therapy was slightly higher than for other groups, mainly because of a relatively greater rate of beta-blocker use (Table 2). However, beta-blockers are often poorly tolerated, especially where the prevalence of both asthma and smoking-associated obstructive lung disease is high, as in Nova Scotia. On the other hand, beta-blockers are highly effective antianginals. Patients unable to tolerate beta-blockers should be relatively more symptomatic and hence more likely to require earlier symptom-modifying surgery.

Vital risks of delayed operation. The risks of delayed bypass surgery appear to be small, although the absence of myocardial infarctions within the period of study likely represents an anomaly. Naylor et al. (23) found preoperative myocardial infarction in 8 of 496 patients (1.6%) awaiting revascularization (bypass surgery or coronary angioplasty) and death in 5 (1%). The death rate while awaiting surgery (1.2%) in our study includes one patient with cardiogenic shock who died within 12 h of admission and 1 h of referral to surgery. If he is discounted, the mortality rate drops below 1%. Indeed, our mortality rate was too low to identify any patient characteristics predictive of death. Whereas Naylor et al. (23) found that patients with left mainstem disease were at increased risk of death, we documented left mainstem disease and severe three-vessel disease as commonly among patients who died as among survivors. Notably, 19.9% of patients ranked semiurgent B and 7.4% ranked elective had severe left mainstem disease. That none died or required reclassification suggests that anatomic findings alone may not be as ominous in patients with stable symptoms and well-maintained functional capacity.

It cannot be assumed that an increase in surgical capacity sufficient to expedite surgery would have saved lives. Four of the five deaths occurred within 9 days of triage. If, for the purpose of comparison, we combine urgent with semiurgent A patients and semiurgent B with elective patients, these four

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patients might have died while awaiting surgery even in a setting with urgent and elective delays comparable to those of the American private care system (24). Furthermore, combining the 5 preoperative deaths on an "intention-to-treat" basis with the 11 perioperative deaths results in a 3.8% figure, which is barely outside the 2.1% to 3.7% perioperative mortality rate calculated from a cross section of university hospitals (36).

Of concern was that 34 patients became unstable and needed their operations moved forward. In retrospect, many had presented with markedly symptomatic angina (modified Canadian Cardiovascular Society classes IVb and IVc). Although they subsequently settled, and their urgency ratings were downgraded accordingly, this degree of symptom severity proved to be a marker for future instability. Greater attention to this feature, as much as the ability to provide prompter revascularization, might obviate problems with similar patients in the future.

Impact of surgical delay on quality of life and economic costs. The impact of delayed revascularization is incompletely measured by patient deaths or other cardiac complications. The effects on patients of persistent symptoms, the anxiety associated with waiting, and the hidden social and economic costs of ongoing medical care, lost work days and sick benefits must also be considered (4,9,37). Surgical delays produced anxiety for most patients that was more than moderate for two-thirds. Although the level of anxiety did not differ across urgency rankings, patients whose waiting times were most protracted bore their anxiety longest. If relative anxiety levels, or tolerance for symptoms, could be measured objectively, then perhaps these should be considered explicitly in the triage process.

Finally, the economic cost of long operative delays was considerable. The additional expense of rehospitalizing the 37 patients whose symptoms worsened amounted by itself to $517,000 Canadian dollars, based on an average daily hospital charge at the Victoria General Hospital of $1,066. Furthermore, two elective patients delayed beyond 20 weeks required repeat coronary angiography at an approximate procedure cost of $1,000 each. A complete analysis would additionally have to include the costs of hospital stays for urgent patients, outpatient visits, lost productivity and income, social benefits and drugs. Whether investment of these dollars into expanded surgical services would lead to expedited surgery, as opposed to an increase in surgical referrals, may be worthy of study.

Does managed delay work? We would prefer not to delay medical or surgical services. Yet even in the United States, the imperative to manage health care costs may require controls on the delivery of services (38). When medically deserving patients are considered equally, it is ethically appropriate to assign precedence to those in whom the procedure can make the greatest difference (9). The overwhelming majority (96%) of our patients surveyed agreed. Our results, and those of others (22,23), suggest that queuing can be performed equitably and with relative safety when explicit triage guidelines are followed. They should not be used to justify long delays that result in a prolongation, if not intensification, of both anxiety and symptoms for many patients and potential economic distress. This is especially true because Canadian patients encounter multiple delays in receiving care. In Nova Scotia, patients wait a mean of 4 weeks from general practitioner referral to elective cardiologist assessment and a further 2 to 4 weeks for elective coronary angiography (28,29).

Yet physician efficiency is constrained by limited medical resources. Our mean delay for elective surgery of 17.4 weeks (122 days) was down from 25.9 weeks in 1991 (28). Clearly, individual delays will vary over time, even within similar urgency categories and even without altering overall surgical capacity. Thus, in order for the system to provide the flexibility to accommodate periodic surges in emergent, urgent or upgraded cases, elective patients will be displaced, and their waiting times accordingly lengthened. Conversely, deaths or cancellations of queued patients may allow others to undergo surgery sooner. This explains, for instance, why four elective patients experienced shorter delays than 48 semiurgent B patients (Table 4). Nonetheless, actual waiting times exceeded local target standards for 49 of 144 (34.0%) semiurgent B and 41 of 56 (73.2%) elective patients. More expeditious surgery will require expansion of revascularization facilities, and this will occur only if it becomes a societal priority or if government believes it might be cost-effective. Preliminary indications that prompt revascularization may in fact generate savings in direct and indirect societal costs (37) merit further study.

Conclusions. It is likely that queuing, in some form, will be a persisting factor in the delivery of health care services. Although negative features exist, positive effects include the promotion of more efficient service utilization (39) and a practical solution to the problem of maintaining universality of health care during a time of fiscal restraint. Continuing assessment of queues and their impact on diverse outcomes is a prerequisite of any triage system, and this study contributes to that end. In addition to monitoring outcomes, health care providers and responsible government agencies or third-party payers should take appropriate actions to maintain waiting times at acceptable levels in terms of minimizing patient jeopardy. Medical delays in Canada are said to provoke "fear and loathing" among American physicians (16). We submit that it should not be the process of managed delay itself that should generate outrage, but rather the failure to improve the process and to provide adequate resources to match the medical need of patients.

Appendix

Guidelines for Establishing Priorities for Isolated Coronary Artery Bypass Surgery at the Victoria General Hospital

In determining priority, two major determinants (type of coronary artery disease and symptom severity) (Table A1) and two minor determinants (left ventricular function and results of noninvasive testing) are used.

Table A1. Symptom Severity and Extent of Coronary Disease

CAD	Modified Canadian Cardiovascular Society Class Angina Classification			
	I–III	IVa	IVb	IVc
Left mainstem	Semiurgent	Urgent	Urgent	Urgent
Multivessel, proximal left anterior descending	Semiurgent	Urgent	Urgent	Urgent
Multivessel, no proximal left anterior descending	Elective	Semiurgent	Urgent	Urgent
Single-vessel, proximal left anterior descending	Semiurgent	Urgent	Urgent	Urgent
One/two-vessel, no proximal left anterior descending	Elective	Elective	Semiurgent	Urgent

CAD = coronary artery disease.

In addition: Functional limitation by stress testing, despite maximal medical therapy, further modifies rankings independent of anatomy as follows: <2 metabolic equivalents (METS) = semiurgent A; 2–5 METS = semiurgent B; >5 METS = elective. Left ventricular ejection fraction less than 40% may lead to a discretionary increase in priority ranking.

Note that stratification does not take into account symptom duration, time from specialist referral or angiography to conference date or such nonmedical issues as employment status. Also, the above are only guidelines, and prioritization may be individualized by consensus depending on clinical circumstances.

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