True versus reported waiting times for valvular aortic stenosis surgery

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OBJECTIVES: To produce a universally accepted waiting time definition for cardiovascular surgery, present the rationale for this definition, and compare data on current waiting times in British Columbia based on this definition versus the current definition in patients waiting for aortic stenosis surgery.

STUDY DESIGN: The present study is a retrospective data analysis.
SETTING: The fixed-dollar, single-payer health care delivery system in British Columbia.

PATIENTS: All residents of British Columbia who were at least 22 years of age and who were placed on a waiting list for aortic valve surgery with the diagnosis of aortic stenosis between January 1, 1991, and December 31, 2000, were eligible for the present study.

INTERVENTIONS: Dates of physician visits, procedures and surgery were obtained from the British Columbia Cardiac Registries and Medical Services Plan databases. True waiting times from physician visits to procedures and surgery were calculated.

RESULTS: Of the 2516 patients booked for aortic valve surgery with a primary diagnosis of aortic stenosis, 2237 subjects (88.9%) were eligible for analysis after exclusions. The eligible patients ranged in age from 22 to 95 years, and 36.8% were female. The true median waiting time was 243 days (148 days [25th percentile], 397 days [75th percentile]), which was 3.2 times the interval currently reported as the waiting time (75 days [42, 127]). Thirty-nine patients died while waiting for surgery. Patients used more resources while waiting for surgery than after surgery.

CONCLUSIONS: True waiting times for surgery for aortic stenosis in British Columbia are significantly longer than reported waiting times. The authors propose that the wait list time for cardiovascular surgery be redefined as "the time interval between the patient's first contact with a medical care provider with symptoms or signs which ultimately lead to cardiovascular surgery and the date of that surgery".

Key Words: Aortic valve stenosis; British Columbia; Canada; Cardiovascular diseases; Prognosis; Waiting lists

Les temps d'attente réels et déclarés pour être opéré d'une sténose aortique valvulaire

OBJECTIFS : Produire une définition universellement acceptée des temps d'attente pour subir une opération cardiovasculaire, présenter la raison d'être de cette définition et comparer les données sur les temps d'attente courants en Colombie-Britannique, d'après cette définition et la définition courante du temps d'attente des patients devant être opérés pour une sténose aortique.

MÉTHODOLOGIE : La présente étude est une analyse de données rétrospectives.

LIEU : Le système de prestation des soins à prix fixe et à payeur unique de la Colombie-Britannique.

PATIENTS : Tous les habitants de la Colombie-Britannique qui avaient au moins 22 ans et étaient inscrits sur une liste d'attente en vue de subir une opération en raison d'une sténose aortique valvulaire après un diagnostic de sténose valvulaire entre le 1^{er} janvier 1991 et le 31 décembre 2000 étaient admissibles à la présente étude.

INTERVENTIONS : Les dates des consultations du médecin, des interventions et de l'opération ont été tirées des registres d'interventions cardiaques de la Colombie-Britannique et des bases de données du régime de santé. Le temps d'attente réel entre la consultation du médecin, les interventions et l'opération a été calculé.

RÉSULTATS : Des 2 516 patients devant subir une opération de la valve aortique en raison d'un diagnostic primaire de sténose aortique, 2 237 (88,9 %) étaient admissibles à l'analyse après exclusion. Les patients admissibles avaient de 22 à 95 ans, et 36,8 % étaient de sexe féminin. Le temps d'attente médian réel était de 243 jours (148 jours [25^e percentile], 397 jours [75^e percentile]), soit 3,2 fois l'intervalle actuellement déclaré (75 jours [42, 127]). Trente-neuf patients sont décédés dans l'attente d'être opérés. Les patients ont utilisé plus de ressources dans l'attente d'être opérés qu'après l'opération.

CONCLUSIONS : Les temps d'attente réels pour être opéré d'une sténose aortique en Colombie-Britannique sont considérablement plus longs que les temps d'attente déclarés. Les auteurs proposent que la liste des temps d'attente en vue d'une opération cardiovasculaire soit redéfinie comme l'intervalle entre le premier contact avec un dispensateur de soins médicaux par suite de signes ou symptômes qui finissent par donner lieu à une opération cardiovasculaire et la date de cette opération.

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Approaches to scheduling cardiac surgery in Canada often involve substantial 'wait times', regardless of whether this is formalized as a waiting list. This approach does not result in any cost savings or 'resource levelling' (1,2). In Canada, the majority of cardiovascular surgical procedures results in increased quality-adjusted life years (3). Therefore, the only use of waiting lists is to distribute the risk of morbidity and mortality 'equally' among the patients on the list.

There is controversy, however, with regard to the presence or magnitude of risk while waiting for cardiovascular procedures. Patients waiting for valve surgery, with or without concomitant coronary artery bypass grafting, are reported in different series to have mortality rates that range from 'a low risk of death' (0.65% to 0.98%) (4) to a 'high' rate of $13.5 \pm 5.0\%$ per patient-year (5). This has led authors to radically different conclusions, some equating waiting lists with "cost effective provision of cardiac services in a fixed-dollar environment" (6), and others stating that waiting on a list is "a lottery that fails to prevent avoidable death" (7).

Part of the problem may lie in the fact that the waiting time studied may be radically different from study to study. For instance, a consensus panel in Ontario suggested specific waiting times (ie, from cardiac catheterization to surgery) that would achieve the goal of equalizing risk among patients (8). This recommendation was only recently adopted in British Columbia and Alberta. In Ontario, however, waiting times are often reported from the time the patient's name is submitted to a central registry by a cardiovascular surgeon to the date of surgery (9,10). Other jurisdictions use other definitions (11,12).

There is evidence that mortality is not linearly related to waiting time (13,14), and that significant mortality and morbidity can occur before a surgeon evaluates a patient (ie, while awaiting catheterization [15]). Therefore, the mortality and morbidity rates determined in different series might relate more to the waiting time tracked than the patient's true risk.

Consequently, a prerequisite for further meaningful debate would appear to be a clear definition of waiting time for cardiovascular surgery. To achieve this, we propose a universal waiting time definition that meets the following criteria:

- The time interval should be representative of the time the patient is at risk for morbidity and mortality.
- The time interval should be applicable and reproducible across all jurisdictions.
- The time interval should be easily and inexpensively tracked (preferably with pre-existing databases).

We know of no currently used waiting time definition in any jurisdiction that meets all three criteria. We therefore propose that the wait time for cardiovascular surgery be redefined as "the time interval between the patient's first contact with a medical care provider with symptoms or signs which ultimately lead to cardiovascular surgery and the date of that surgery".

We present the rationale for this definition, and compare current waiting times in British Columbia based on the proposed definition versus the current definition in patients with aortic stenosis waiting for surgery. We chose patients with aortic stenosis due to the well-established survival benefits of surgery and risks of waiting (5,16,17).

Ultimately, the discussion of waiting times only 'comes alive' as a means of meaningfully identifying the costs to both patients

and the health care system of a health care strategy where there are significant delays in accessing potentially life-saving surgery. To underscore our contention (and that of others) that the imposition of significant waiting times is an ineffective strategy for rationing health care costs, we include data on resource utilization during the true waiting time period compared with the period after surgery. We provide information on deaths occurring during the true waiting time to illustrate the potential costs of waiting times to patients and to assist in the determination of future benchmarking targets for cardiac surgery waiting times.

METHODS

Population

All residents of British Columbia who were at least 22 years of age and who were placed on a waiting list for aortic valve surgery with the diagnosis of aortic stenosis between January 1, 1991, and December 31, 2000, were eligible for the present study.

Data

In British Columbia, all medically insured services must be provided through the public system, and all visits to specialists (internists, cardiologists or cardiovascular surgeons) by outpatients require a referral from a primary care practitioner. The British Columbia Cardiac Registries database captures demographic, procedural and prognostic information on all residents undergoing open-heart surgery or percutaneous coronary intervention in British Columbia. For outpatients, the database also records the date on which a surgery is booked. All specialist services tracked in the present study, and over 95% of primary care services, are billed through a 'fee-for-service' model. For every service performed, a unique patient and service identifier (billing code) is submitted with the date of service into the Medical Services Plan database.

Dates for diagnostic procedures (ie, echocardiography and diagnostic cardiac catheterization) and visits to physicians (internists/cardiologists, primary care physicians and cardiovascular surgeons) were obtained from the Medical Services Plan database using a patient-specific, unique identifier.

Probabilistic linkage with the Vital Statistics database, using personal health number, surname, first name, middle initial, date of birth and sex, provided mortality information.

Definitions

Five waiting time intervals were defined for the present study.

Booking to surgery: The time from the date surgery is booked (ie, the patient is added to the British Columbia Cardiac Registries wait list database) to the date of surgery. The wait list is surgeon-specific. Therefore, if a patient was removed from one surgeon's wait list and placed on another within 30 days, then the waiting time was calculated from the first time the patient was booked for surgery. If the time between withdrawal from a previous wait list to assignment on another surgeon's wait list exceeded 30 days, then the waiting time was calculated from the time the patient was listed on the subsequent (second surgeon's) wait list.

Procedure to booking: The time from the date of a Medical Services Plan billing for echocardiography or left heart catheterization to the date surgery was booked. The procedure most proximal to the booking date (not exceeding two years) was selected. Diagnostic procedures occurring more than two years before booking for surgery were excluded because they were unlikely to be related to the surgical procedure.

Internist to testing: The time from the date of a Medical Services Plan billing for an internist/cardiologist consultation to the date that cardiac catheterization or echocardiography was performed. If only one diagnostic test was performed, then the internist visit most proximal to the diagnostic procedure was chosen. If both cardiac catheterization and echocardiography were performed, then the visit most proximal to the first diagnostic test was selected. Internist visits exceeding one year before diagnostic testing were excluded.

Primary care physician to internist: The time between the visit to a primary care physician and the visit to an internist/cardiologist. The visit date most proximal to the visit to the internist/cardiologist (not exceeding six months) was selected. Primary care visits greater than six months before the specialist visit were not included because these visits were unlikely to have generated the referral.

Primary care physician to surgery: The interval between the primary care visit identified by the above protocol and surgery.

Death while waiting for surgery was defined as death from any cause in patients who did not undergo surgery. The interval between the date when cardiac surgery was booked and the date when data collection ended (December 31, 2001) was examined.

In addition, a patient was said to have deteriorated clinically (defined as 'clinical deterioration') if the recorded urgency status at the time of operation was of a higher category than the urgency status recorded at the time that surgery was booked. For instance, a patient was said to have deteriorated if the status at booking time was 'elective', while urgency at surgery was defined as 'emergency'.

The Medical Services Plan billing codes utilized for diagnostic tests and physician visits are listed in the Appendix.

Analysis

Descriptive statistics, including median and interquartile ranges, were computed for each of the waiting time intervals described above. The Wilcoxon rank-sum test was used to compare these intervals between urgent cases (priority II) and elective cases (priority III), and to compare surgical outcomes (ie, total hospital or coronary care unit length of stay). χ^2 tests were used to compare binary outcome variables, such as operative mortality and rate of coronary care unit stay.

Ethics

The study was conducted with the approval of the institutional ethics committee.

RESULTS

Study sample

Of the 2516 patients booked for aortic valve surgery with a primary diagnosis of aortic stenosis, 2237 subjects (88.9%) were eligible for analysis after exclusions were made for inpatient procedures and withdrawal from the waiting list (Figure 1). The eligible patients ranged in age from 22 to 95 years, and 36.8% were female. Of the 2237 patients eligible for analysis, 2187 (97.8%) eventually had surgery, 39 (1.7%) died while waiting for surgery, and 11 (0.5%) remained on the waiting list after December 31, 2001, when data collection ended.

Of the 2187 patients who had surgery, 1943 (88.8%) had aortic stenosis listed as the paramount reason for their surgery. Reflecting this fact, 1066 patients (48.7%) only underwent an aortic valve procedure, while 821 patients (37.5%) underwent an aortic valve procedure and coronary artery bypass grafting. A further 165 patients (7.5%) underwent an aortic valve and other (mostly mitral) valve procedure, and 109 patients

Figure 1 Derivation of study sample

(5.0%) underwent an aortic valve and a nonvalve, noncoronary artery bypass (mostly aortic root) procedure. Twenty-six (1.2%) of the patients originally booked for aortic valve surgery had no aortic procedure performed.

Eighty-three patients (3.8%) died within 30 days of their surgery, and a further 62 patients died within a one-year follow-up period.

Among the 2187 patients who had surgery, 320 (14.6%) had their clinical status deteriorate while waiting. Their 30-day postoperative mortality was not significantly different from those whose clinical status remained unchanged (4.7% versus 3.5%, respectively; $P=0.32$). However, those 320 patients consumed more hospital resources than did patients whose clinical status remained unchanged in terms of total length of stay (median of 10 days [eight days (25th percentile), 15 days (75th percentile)] versus nine days [eight days, 12 days], respectively; $P<0.001$) and coronary care unit use (16.6% versus 5.2%, respectively; $P<0.001$), with a trend toward a longer coronary care unit stay (median of four days [one day, five days] versus two days [one day, four days], respectively; $P=0.08$).

The differences in the number of physician visits (including emergency room visits if the patient was not admitted) and hospital admissions for cardiovascular-related diagnoses (*International Classification of Diseases, Ninth Revision* [18] codes 390 to 429, and 785) for patients who had surgery between January 1, 1992, and December 31, 2000, were calculated. The 11 preoperative months and 11 postoperative months were compared (Figure 2). Preoperatively, there were 959 hospital admissions (3295 hospital days) and 10,392 outpatient physician visits. Neither physician visits nor hospital days were generated on the day of surgery and for 30 days postoperatively in

Figure 2) Study period diagram. op Operative

an attempt to separate surgery-related from nonsurgery visits and hospital days.

Postoperatively, there were 206 hospital admissions (1026 hospital days) and 9680 outpatient physician visits. Overall, 753 more hospital visits (2269 hospital days) and 712 more physician visits occurred in the 11 preoperative months versus the 11 postoperative months.

A fee record with a billing code for a cardiac catheterization and/or outpatient echocardiogram within the time frame described was identified for 2087 (95.4%) patients. Among the 2087 patients with matched diagnostic procedures, 1736 (83.2%) had an internal medicine visit. And among the 1736 patients with a matched internal medicine visit, 1619 (93.3%) had a matched visit to their primary care physician.

Waiting times

The waiting time intervals are shown in Table 1. The waiting time intervals are subdivided into those designated by the surgeon as 'urgent' and those designated 'elective' at the time their names were added to the waiting list. The median waiting interval from the time of the primary care physician visit to surgery was 243 days (148 days, 397 days). This interval was 3.2 times the interval currently reported as the 'waiting time' (booking to surgery: median 75 days [42 days, 127 days]).

The waiting time intervals for primary care physician to internist, internist to testing and testing to booking were no different for those ultimately deemed urgent and those ultimately deemed elective (Table 1).

DISCUSSION

In cardiovascular diseases, where good natural history studies are available, a patient's risk for morbidity and mortality accelerates at the time of symptom onset, or when a change in symptom frequency or severity occurs. This is most well established for aortic stenosis (19-21). We therefore propose that the wait list time for cardiovascular surgery be redefined as "the time interval between the patient's first contact with a medical care provider with symptoms or signs which ultimately lead to cardiovascular surgery and the date of that surgery". The present study highlights the dramatically longer real wait times (3.2 times longer) compared with the reported wait times in British Columbia. We believe that similar discrepancies would be highly likely in other fixed-dollar jurisdictions, such as the National Health Service in the United Kingdom and certain health maintenance organizations in the United States.

The failure to recognize the entire waiting period has the inadvertent effect of significantly affecting the process of 'appropriately' allocating risk. The waiting intervals for primary

TABLE 1
Median waiting times (days) by interval and urgency status

Interval	Status	n	Median	25th percentile	75th percentile
Booking to surgery*†	Total	2187	75	42	127
	Urgent	1709	67	37	114
	Elective	478	107	63	170
Procedure to booking	Total	2087	62	20	134
	Urgent	1632	62	20	129
Internist to testing‡	Total	1736	24	8	67
	Urgent	1349	23	8	67
	Elective	387	26	8	65
Primary care physician to internist	Total	1619	22	0	48
	Urgent	1259	22	10	48
	Elective	360	23	10	47.5
Primary care physician to surgery*†	Total	1581	243	148	397
	Urgent	1229	228	139	371
	Elective	352	278	189	468

*Includes only those patients who had surgery; † $P < 0.01$ by the Wilcoxon rank-sum test, urgent versus elective cases. All other intervals were not statistically significantly different; ‡The time from the date of a Medical Services Plan billing for an internist/cardiologist consultation to the date that cardiac catheterization or echocardiography was performed (see text). In 89.4% of patients, the echocardiogram was performed before the catheterization. The median wait time from echocardiography to catheterization was 72 days (38 days [25th percentile], 125 days [75th percentile]) for urgent patients and 72.5 days (30 days [25th percentile], 133 days [75th percentile]) for elective patients

care physician to internist, internist to testing and testing to booking are no different for those ultimately deemed urgent and those ultimately deemed elective (Table 1). The primary care physician to procedure time for urgent cases is statistically significantly shorter for urgent patients than for elective patients, but all of the difference is accounted for by the shorter booking to procedure time in the urgent group. The currently reported waiting time (booking to surgery) for urgent patients is only 62.6% of that of elective patients. However, the actual waiting time (primary care physician to surgery) for urgent patients is fully 82.2% of that of elective patients. Thus, failure to achieve timely access to visits and procedures delays surgical intervention that would otherwise ensure that those at highest risk are moved quickly through the system. Indeed, our data show that the urgency rating only speeds patients through 30.9% of the total waiting time!

Waiting does not appear to be a benign process for the patient or the system. Thirty-nine patients (1.7%) died during the currently reported waiting time, a rate of 0.5% per month. Postoperatively, the rate of death was 0.4% per month. As well, one in seven patients deteriorated during their wait, and these patients used significantly more resources than patients who did not deteriorate.

A rational discussion of important issues concerning the emotionally charged area of waiting lists for medical procedures requires reliable, reproducible data. This can only be accomplished with a clear definition of the variables measured. We also believe that resources need to be committed, and data collection and analysis be performed, at arms length from funding agencies or others with a vested interest other than the patient's outcome.

We believe that adoption of the proposed waiting list is essential to determine the true risk of mortality and morbidity while waiting for valvular aortic stenosis surgery, which will allow individuals to be counselled about the risk they face while waiting. This, in turn, allows for meaningful decision-making on the part of individual patients in multiple-payer health care systems where private cardiac surgery is available.

We believe that our definition, with appropriate modifications (that do not detract from its ability to track the time interval a patient is at risk), can be used for cardiovascular procedures in general. In addition, inadvertent or purposeful manipulation of the system that appears to shorten the waiting time but actually increases patient risk would be more difficult using the proposed definition. For instance, using the current definition of waiting time in British Columbia (booking to surgery), the waiting list could be reduced to zero by ceasing performance of all echocardiograms and cardiac catheterizations. No appropriate patients for aortic valve surgery would be identified, the current waiting lists would be cleared, and no mortality while waiting would occur. Our proposed definition would achieve the goal of capturing all morbidity and mortality associated with waiting. This is the rationale for 'starting the clock' at the time of signs or symptoms.

Our proposed definition would also allow for a more valid comparison of data from different jurisdictions, ensuring that observed differences in risk profiles for patients awaiting aortic stenosis surgery are not artifacts arising out of differing ways in which the waiting times are measured.

We have also demonstrated that patients waiting for aortic stenosis surgery consume significantly more resources in the period leading up to surgery, and that this declines after surgery is performed. This finding calls into question the idea that waiting lists provide a truly cost-effective method for rationing cardiac surgical resources.

STUDY LIMITATIONS

We were unable to detect deaths that may have occurred in the interval between contact with the primary practitioner and booking for surgery. We therefore believe that the 39 patients who died are likely to be an underestimate, in that only the deaths from the time of booking for cardiac surgery could be tracked. In the present study, we retrospectively tracked patient visits to medical care providers and for diagnostic testing. While this approach is feasible, certain assumptions regarding the timing of visits were made that could have introduced error in the calculations. A more accurate approach would be to prospectively track patients. This could be accomplished if the primary care physician would code an appropriate *International Classification of Diseases, Ninth Revision* code in the Medical Services Plan billing data and the fact the patient was referred for an internist/cardiologist consultation. The internist/cardiologist or primary care physician would also need to code all referrals to cardiovascular surgeons.

There are other significant limitations in our study. The data do not capture waiting times for patients to see their primary care practitioners. We purposely tracked only the time from the last primary care visit to a specialist visit or diagnostic procedure, without assurance that this visit generated the request for the visit or diagnostic procedure. If a patient saw an internist while waiting for a cardiac catheterization or echocardiogram, then this fact would shorten the reported internal medicine visit to procedure time. For diagnostic

procedures, we tracked the time from the earlier procedure (cardiac catheterization or echocardiography) to surgery. In general, our assumptions would tend to result in our wait list times being underestimated. These issues, while rendering some imprecision in our ability to determine waiting times using our current method, also lend strength to our argument for adoption of our proposed wait list time definition.

We have demonstrated that aortic stenosis patients consume more resources in terms of hospital admissions and outpatient visits while waiting for surgery than they do after surgery. To comprehensively determine the cost implications of our data would require further cost analysis, including the modelling of different waiting times and their impact on resource utilization.

CONCLUSIONS

A valid, comparable and feasible definition of waiting time is an essential prerequisite to any meaningful discussion of the risk incurred by patients who are kept waiting for cardiac surgery and the cost of this waiting time to the health care system. Such a definition would reflect the time a patient is at risk for increased morbidity and mortality, would be comparable across jurisdictions, and would be traceable using inexpensive methods (ie, pre-existing databases). We therefore propose that the wait list time for cardiovascular surgery be redefined as "the time interval between the patient's first contact with a medical care provider with symptoms or signs which ultimately lead to cardiovascular surgery and the date of that surgery".

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APPENDIX

Billing codes* used to track visits and procedures

Primary care physician consult or visit	100, 101, 103, 13100, 13101
Internal medicine consultation or visit	307, 310, 312
Echocardiography	391, 8638, 8643, 8679
Cardiac catheterization	812, 827, 830, 841

*All codes are as listed in the *British Columbia Medical Association's Guide to Fees* (22)

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