How established wait time benchmarks significantly underestimate total wait times for cardiac surgery

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BACKGROUND: Wait times for cardiac surgery are well established but may not reflect the total wait time patients experience.

METHODS: The Maritime Heart Center (Halifax, Nova Scotia) cardiac surgery database was used to identify all consecutive patients who underwent elective coronary artery bypass graft surgery between 2002 and 2005 from a single urgency queue. The provincial physician billing database provided a timeline record of dates, physician visits, and diagnoses or procedures performed for each patient. This information was used to assess total and component wait times leading to cardiac surgery.

RESULTS: A total of 705 consecutive patients were included and stratified based on geographical location: urban Halifax Regional Municipality (HRM; n=222), urban non-HRM (n=220) and rural (n=263). Patients from all regions did not differ in age, sex, comorbidities or ventricular function. Using a traditional definition of wait time (time listed), patients waited a median of 56 days (interquartile range [IQR] 38 to 77 days). In comparison, the total wait times based on the time from presentation to surgery were a median of 109 days (IQR 56 to 184 days) for HRM, a median of 121 days (IQR 77 to 184 days) for urban non-HRM and a median of 123 days (IQR 79 to 169 days) for rural patients (P-value nonsignificant). Two modes of presentation emerged that were not influenced by a patient's geographical location. Patients who presented to the emergency department (n=229) waited a median of 73 days. This was significantly less than patients who presented to their family physician (n=476), who waited a median of 135 days (P<0.001). The difference in overall wait for patients presenting to the emergency room was a result of a shorter wait time for referral to a specialist and from seeing a specialist to catheterization.

CONCLUSION: The present pilot study demonstrated that total patient wait times for cardiac care and surgery in Nova Scotia are significantly longer (more than twofold) than traditionally reported wait times for surgery alone.

Key Words: Administrative data; CABG; Outcomes; Registry; Wait time

Wait times for health care has been a popular topic in recent discussions of health care management and reform. However, the media tends to focus on wait times for surgery and high-technology imaging tests. These late-stage wait times are only a portion of the total wait time leading up to surgery. Thus, current metrics underestimate the total wait time surgical patients experience. For example, Munt et al (1) have found that current methods underestimate the wait time for surgical treatment of aortic stenosis by a factor of 3.2. Knudtson et al (2) have proposed that it is likely that patients face the greatest wait-related risk in the earlier phases of care, before the disease is adequately characterized.

Recently, a number of authors have suggested alternate ways of defining wait times to reflect the patient's perspective on waiting for care. For example, Munt et al (1) have proposed that the wait time for

En quoi les normes de temps d'attente établies sous-estiment considérablement les temps d'attente totaux avant une chirurgie cardiaque

HISTORIQUE : Les temps d'attente avant une chirurgie cardiaque sont bien établis, mais ne reflètent pas le temps d'attente total que vivent les patients.

MÉTHODOLOGIE : Les auteurs ont utilisé la base de données des chirurgies cardiaques du *Maritime Health Centre* de Halifax, en Nouvelle-Écosse, pour repérer tous les patients consécutifs qui avaient subi un pontage aortocoronarien non urgent entre 2002 et 2005 et qui provenait de la même liste d'attente. La base de données provinciale de facturation par les médecins a fourni un calendrier des dates, des visites chez le médecin et des diagnostics ou des interventions exécutées auprès de chaque patient. Ces renseignements ont permis d'évaluer le temps d'attente total et celui de chaque volet avant la chirurgie cardiaque.

RÉSULTATS : Au total, 705 patients consécutifs ont été inclus dans l'étude et stratifiés selon leur lieu géographique : municipalité régionale du Halifax urbain (MRH, n=222), région urbaine hors MRH (n=220) et région rurale (n=263). Les patients de toutes les régions ne différaient pas selon l'âge, le sexe, les comorbidités et la fonction ventriculaire. Au moyen de la définition traditionnelle des temps d'attente (le temps inscrit), les patients attendaient une médiane de 56 jours (plage interquartile [PIQ] de 38 à 77 jours). En comparaison, le temps d'attente total d'après le délai entre la présentation et l'opération était d'une médiane de 109 jours (PIQ de 56 à 184 jours) dans la MRH, d'une médiane de 121 jours (PIQ de 77 à 184 jours) dans la région urbaine hors MRH et d'une médiane de 123 jours (PIQ de 79 à 169 jours) chez les patients des régions rurales (valeur P non significative). Deux modes de présentation qui n'étaient pas influencés par le lieu géographique des patients ont émergé. Les patients qui consultaient à l'urgence (n=229) attendaient une médiane de 73 jours. C'était considérablement moins long que les patients qui consultaient leur médecin de famille (n=476), qui attendaient une médiane de 135 jours (P<0,001). La différence des temps d'attente globaux pour les patients qui arrivent à l'urgence résultait d'un moins long délai avant d'être orientés vers un spécialiste et entre la consultation d'un spécialiste et le cathétérisme.

CONCLUSION : La présente étude pilote démontre que le temps d'attente total des patients avant de recevoir des soins cardiaques et de se faire opérer en Nouvelle-Écosse est considérablement (plus de deux fois) plus long que les temps d'attente habituellement déclarés avant la seule chirurgie.

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". This would effectually lead to an examination of the total wait time surgical patients experience. These authors propose that a universal wait time definition must meet three 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; and the time interval should be easily and inexpensively tracked, preferably with pre-existing databases (1,2).

The present study represents pilot work designed to examine the feasibility of using administrative databases, specifically Nova Scotia's Medical Services Insurance (MSI) physician billing database, to

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obtain data to calculate wait times and analyze patients undergoing elective cardiac surgery. We hypothesized that the wait times reported for cardiac surgery alone is a gross underestimate of the total wait time from the patient's perspective. We divided total wait time into three major components: wait for specialist visit, wait for cardiac catheterization and wait for surgery.

METHODS

Population

Patients eligible for coronary artery bypass graft (CABG) surgery at the Queen Elizabeth II Health Sciences Centre in Halifax, Nova Scotia, have traditionally been divided into four categories based on urgency. Indications for CABG surgery were based on a weekly peer review process involving cardiologists, cardiac surgeons and cardiac radiologists. Individual patients were queued for surgery based on objective criteria as previously described (3,4). Briefly, patients were queued according to standard criteria, with two major determinants (anatomy of coronary disease and symptom severity) and two minor determinants (left ventricular function and results of noninvasive testing). All patients were stratified into four different wait categories. Emergent surgery patients were defined as unstable patients requiring immediate intervention. In-house urgent patients were defined as patients with Canadian Cardiovascular Society (CCS) class IV symptoms who were kept in the hospital before surgery. In the two remaining queues, clinically stable patients (CCS class I to III) were discharged home while waiting for surgery and stratified using objective functional testing. Semiurgent A patients scored less than two metabolic equivalents on a stress test using the standard Bruce protocol. Semiurgent B (SUB) patients scored between two and five metabolic equivalents on the exercise stress test. Patients who presented to the hospital on an emergency basis underwent surgery immediately as clinically indicated and were defined in the present study as the emergent queue. It was decided that only SUB patients would be included in the present study, allowing for focus on a select group of patients generally considered to be low risk for surgery. Selection criteria for the present study included patients undergoing isolated SUB CABG surgery at the Queen Elizabeth II Health Sciences Centre between 2002 and 2005. Exclusion criteria included upgrade to a more urgent status, previous CABG surgery and previous percutaneous coronary intervention (PCI).

Data

The present study was a retrospective data analysis that used two established and linked databases – the Maritime Heart Center (MHC) cardiac surgery database and the physician billing database. The MHC database is a prospectively collected clinical database that collects pre-, intra- and postoperative information on all patients undergoing cardiac surgery at the MHC. This database was used to identify all patients meeting the selection criteria; additional subject information was obtained from the Population Health Research Unit (PHRU), a Dalhousie University-based research and support group conducting population health and health services research. The Nova Scotia provincial government has supplied PHRU with complete Medicare, Pharmacare and hospital files suitable for research purposes, as well as a variety of other data sources including clinical databases and large-scale population surveys. These individual databases have been linked to create a comprehensive MHC data registry. All databases involved in the present study contained an encrypted provincial medical insurance number as a unique identifier that was used to link patient records. The encryption process was performed by the provincial Department of Health to ensure patient anonymity. Eligibility codes for medical insurance were examined to identify patients with interruptions in insurance coverage.

Of particular relevance to the present study was the data collected by PHRU from Nova Scotia's MSI records. Specifically, the present study used the physician billing database, which is a subcomponent included in the PHRU database system that contains administrative records for each insured health service rendered by a physician and

paid for by the Nova Scotia provincial health care system. Under this remuneration program, physicians delivering health services in Nova Scotia and therefore billing under this system, must record all patient visits using standardized data entry forms, and all diagnoses or procedures performed must be reported using the appropriate codes as outlined by the *Canadian Classification of Health Interventions* (CCI) and the *International Statistical Classification of Diseases and Related Health Problems* (ICD). The physician billing database includes patient information, physician information, date of services, and the exact diagnoses and procedures performed, giving a timeline record of health services used across many health care settings for each patient included in the study. This information was used to calculate total and component wait times leading up to CABG surgery.

Definitions

Three wait time intervals were defined for the present study.

1. Wait for referral to a specialist (general internist or cardiologist) – calculated as the time interval between the last visit to the general practitioner's office with ischemic heart disease-related complaints and the first visit with an internist or cardiologist for the same complaint (for specific ICD codes, refer to Appendix 1)
2. Wait for catheterization – calculated as the time interval between the last visit with the internist or cardiologist and the date of catheterization (for specific ICD codes, refer to Appendix 1). Note that the wait time from the first to the last visit with the specialist was included in the total wait time.
3. Wait for surgery – calculated as the time interval between date of catheterization and date of surgery (for specific ICD codes, refer to Appendix 1). Note that this time interval is the time traditionally reported and used to set wait time standards for cardiac surgery.

Analysis

Descriptive statistics, including median and interquartile ranges (IQRs), were computed for each of the wait time intervals described above. A natural logarithmic transformation was applied to wait times to achieve a normal distribution. Wait time intervals among groups were evaluated using ANOVA, and post hoc means were compared using the Tukey-Kramer standardized range test. Total wait time differences between groups were analyzed based on patient characteristics, including age, sex, geography, cardiologist availability, neighbourhood education level and neighbourhood income levels. A logistic regression model was used to predict the probability of presenting to the emergency department rather than to the general practitioner.

Ethics

The present study was conducted with the approval of the institutional (Capital District Health Authority) ethics committee. The data used in the present report were made available by the PHRU of Dalhousie University. Although the present research was based on data obtained from the PHRU, the observations and opinions expressed are those of the authors, and do not represent those of the Population Health Research Unit.

RESULTS

Study sample

During the present study period, a total of 922 consecutive patients were stratified into the SUB CABG surgery queue from a group of 2561 patients booked for elective CABG surgery (36%). Two hundred seventeen patients were excluded because of a history of CABG, PCI or upgrade to another queue (Figure 1). The final study population consisted of 705 patients. Patient geographical residence was determined by address, using postal codes and software from Statistics Canada. All patients were divided into three groups based on geographical location of residence: within the Halifax Regional Municipality (HRM) (n=222), urban non-HRM (n=220) and rural (n=263) Nova Scotia. Patient characteristics for HRM, urban non-HRM and rural groups are outlined in Table 1. The groups were similar

Figure 1 Flow diagram illustrating patient recruitment and exclusion from the study between 2002 and 2005. The total recruitment was 28% of all coronary artery bypass graft (CABG) surgeries during the same period. HRM Halifax Regional Municipality (Nova Scotia); PCI Percutaneous coronary intervention

TABLE 1
Patient characteristics

Characteristic	HRM (n=222)	Urban non-HRM (n=220)	Rural (n=263)	P
Age, years, mean $\pm$ SD	63 $\pm$ 10	63 $\pm$ 10	64 $\pm$ 10	0.62
>70 years	28	27	31	
Female sex	15	24	21	0.06
Diabetes	41	41	33	0.13
Renal failure	5	1	2	0.08
Hypertension	73	71	70	0.82
Hypercholesterolemia	93	97	95	0.22
PVD	21	14	19	0.06
CVD	13	10	16	0.11
Combined PVD/CVD	27	20	30	0.04
COPD	15	18	14	0.53
Previous MI (<21 days)	0.9	0.5	0.4	0.84
Ejection fraction <40%	7	8	6	0.67
LM stenosis >50%	13	11	13	0.69
Diseased vessels				
Single	3	9	4	0.02
Double	19	23	20	
Triple	78	68	76	

Data presented as % unless otherwise indicated. COPD Chronic obstructive pulmonary disease; CVD Cerebrovascular disease; HRM Halifax Regional Municipality (Nova Scotia); LM Left main; MI Myocardial infarction; PVD Peripheral vascular disease

in terms of patient characteristics, with 28% of patients older than 70 years of age, predominantly men, having a normal ejection fraction and having three-vessel coronary artery disease.

Wait times

Using traditional definitions for wait time (time on surgical wait list from cardiac catheterization to surgery), patients waited a median of 56 days (IQR 38 to 77 days) for an established benchmark of 52 days (4). In comparison, the actual wait times reported in the present study represent the summated referral to specialist wait, specialist to catheterization wait and catheterization to CABG surgery wait. As such, the total actual wait times experienced by patients were a median of 109 days (IQR 56 to 184 days) for HRM, a median of 121 days (IQR 77 to 184 days) for urban non-HRM and a median of 123 days (IQR 79 to 169 days) for rural patients ($P=0.18$). The mean wait times are illustrated in Figure 2A, with no significant differences between geographical regions. Two modes of presentation emerged; patients who

Figure 2 A Mean wait times in days between geographical regions. B Mean wait times between modes of presentation. Results are expressed as mean $\pm$ SEM. * $P<0.05$. ER Emergency room; GP General practitioner; HRM Halifax Regional Municipality (Nova Scotia)

presented to the emergency room (ER) ($n=229$) waited a median of 73 days, which was significantly less than patients who presented to their general practitioner ($n=476$), who waited a median of 135 days regardless of region ($P<0.001$). Mean wait times are shown in Figure 2B, illustrating a significantly shorter wait time for patients presenting to the ER.

Median wait times from presentation to specialist, specialist to cardiac catheterization and catheterization to surgery were illustrated as the percentage of time spent along the spectrum between geographical region and mode of presentation (Figure 3). Overall, 50% to 60% of the median patient wait time was spent on a wait list for surgery (catheterization to surgery). No significant differences were noted between geographical regions. The reduction in overall wait for patients presenting to the ER was a result of a reduction in the referral to specialist wait and the specialist to catheterization wait, rather than a shorter surgical wait time, reflecting similar perceived urgency based on previously described objective criteria (3-5). One should also note that overall, the median wait time from presentation to specialist was longer in the HRM ($P<0.01$) and wait time from specialist to catheterization was shorter in the HRM than in other regions ($P<0.05$) (Figure 3A).

Using logistic regression analysis, a model was created to predict which patients were more likely to present to the ER than to their general practitioner. The model was created using primarily patient variables, but did include geographical region with a c-statistic of 0.68.

Figure 3) Wait times were divided into wait time from initial presentation to seeing a specialist (grey), wait time from specialist to cardiac catheterization (cath) (white) and wait time from cardiac cath to surgery (OR) (black). The percentage of total wait time spent between regions and mode of presentation are shown for all patients (A), presentation to the general practitioner (B) and presentation to the emergency room (ER) (C). HRM Halifax Regional Municipality (Nova Scotia). SUB Semiurgent B

A history of congestive heart failure (OR 2.3; 95% CI 1.17 to 4.64) and previous myocardial infarction (OR 2.81; 95% CI 1.99 to 3.96) were found to be independent predictors of presenting to the ER with an ischemic heart disease complaint (for ICD codes, refer to Appendix 1). Geographical region was not predictive.

Patient outcomes

In-hospital outcomes are outlined in Table 2. The in-hospital mortality rate was 1.7%. A composite adverse cardiovascular outcome was used to compare outcomes between groups, and included mortality, perioperative MI, low-output syndrome and prolonged hospitalization (more than nine days). Using this approach, no significant differences were found in the incidence of the composite outcome between geographical regions, mode of presentation or waiting longer than the established benchmark (52 days).

DISCUSSION

Tremendous political efforts have been made nationally to implement wait time standards for health care delivery (6). This is particularly true for cardiac conditions, which are often amenable to evaluations based on index events such as cardiac catheterization and listing for surgery, which is captured by institutional, provincial and national datasets (1,7,8). We argue that, unfortunately, such wait time data underestimate the total wait time experienced by patients, which includes intervals in which the patient is waiting for different things

TABLE 2
In-hospital outcomes

Outcome	%
Mortality	1.7
Perioperative myocardial infarction (MI)	0.3
Low cardiac output syndrome (LOS)	1.7
Length of stay >9 days	10.8
Adverse composite outcome (death, MI, LOS, prolonged stay)	12.8

and different people. In cardiac surgery, this may include consultation with a specialist, specialist assessment, electrocardiography, cardiac catheterization, surgical consultation, official surgical waiting list registration and, finally, surgery (9). Perhaps a more useful approach to re-examination and standardization of wait time definitions comes from the report by Sanmartin and the Steering Committee of the Western Canada Waiting List Project (10), who advocate for the 'path-to-care' approach in defining wait times. This approach encourages the separate consideration of each of the individual time intervals identified in the path toward surgery, including those for access to primary care, access to specialist consultation, the decision to treat (including wait time for major diagnostic tests and wait time for subsequent surgical consultation), and finally, the wait time for surgery. This approach is superior because it considers total wait time from the patient's perspective, and also allows for the examination of where in the pathway wait times are unacceptable or cause a delay, thus allowing policy makers to identify specific targets for wait time improvement.

The present study was designed to examine the feasibility of using administrative databases, specifically the physician billing database obtained from Nova Scotia's MSI records, to obtain data for wait time calculation and analysis. The physician billing database has many advantages over traditional chart reviews. It is less time consuming to obtain and analyze information because all data are computer readable. This administrative database captures the majority of patients, with virtually 100% of the population being eligible for MSI health coverage. The database is easily accessible, readily available and inexpensive to acquire. The ability to track services used by persons across multiple care settings (including hospitals, physicians' offices, nursing homes, etc) enhances the power of the administrative data. Finally, patient confidentiality can be maintained by the use of encrypted patient identifiers. To our knowledge, only one published study to date (1) has taken advantage of the physician billing database to calculate wait times for cardiac surgery.

Our results clearly illustrate that the traditionally reported wait time grossly underestimates (more than twofold) the actual wait time individual patients experience with symptomatic ischemic heart disease and waiting for CABG surgery. We have shown that in this select group of patients, the median wait time from presentation to surgery was greater than 100 days and the mean wait time was more than 145 days. While our approach using administrative data is advantageous for large-scale wait time research, certain assumptions regarding the timing of visits were made that may have introduced error into the wait time calculations. One should also note that we used the last primary physician visit as the index visit before the visit with a specialist, which may have underestimated the wait time from presentation to a specialist. In fact, many patients were visiting their general practitioner with the same complaints on several occasions before seeing the specialist. This is an important limitation of using physician billing data because it provides only a diagnostic code(s) and date, and no information on actual referral requests. We arbitrarily chose to use the last visit to provide a conservative estimate of the wait time. The present study is also unable to estimate the wait to see a general practitioner, which may vary between regions and individual practices (11).

The study population we chose represents a relatively

homogeneous group of patients who were stratified, based on objective criteria, into an urgency queue for CABG surgery that has an established standard of 52 days based on historical published evidence (5). This statement is supported by the median wait time of 56 days spent on a wait list for surgery (catheterization to surgery wait time). This wait time from catheterization to surgery was stable between geographical region and mode of presentation. The novel finding here is that patients who presented to the ER, rather than their general practitioner, had significantly shorter overall wait times. Furthermore, the observed reduction in wait time was entirely due to a shorter wait to see a specialist and a shorter wait for cardiac catheterization. One should note that we were limited by a small sample size, and thus, reduced statistical power to allow further risk modelling or subgroup analysis.

We have found the physician billing database to be useful in wait time research, allowing researchers to avoid the time-consuming chart reviews often involved in such analyses, and thus making large-scale wait time research less expensive and more feasible. The physician billing database may be used in the future to calculate present wait times for various health care services, as well as to evaluate the efficacy of various policy and program changes aimed at improving wait times. For example, studies may identify the population potentially affected by a particular policy or funding change, define an appropriate comparison group, measure important baseline variables, and ascertain study outcomes using the physician billing database.

We support a 'path-to-care' approach in examining wait times (10). Total wait time for cardiac care and surgery will include intervals where the patient is waiting for different people and different things. Many groups setting wait time benchmarks or guidelines have already

suggested this kind of approach (6,12). Future examination of wait times should follow this trend and take into consideration wait for care along the entire trajectory, instead of focusing solely on late-stage interventions and surgery. A better understanding of the various delay intervals leading up to surgery, as well as the numerous patient variables influencing wait times, will allow physicians and policy makers to focus reform and efficiency improvements directly on specific targets on the cardiac care trajectory.

APPENDIX 1

Data obtained from the physician billing database

1. Referral from primary care physician to specialist
 - a. ICD-9 diagnosis of coronary disease: 410 (acute myocardial infarction), 411 (other acute and subacute forms of ischemic heart disease), 413 (angina pectoris), 414 (other forms of chronic ischemic heart disease)
 - b. ICD-10 diagnosis of coronary disease: I20 (angina pectoris), I21 (acute myocardial infarction), I22 (subsequent myocardial infarction), I24 (other acute ischemic heart diseases), I25 (chronic ischemic heart disease)
 - c. Date of service
 - d. Treatment location
 - e. Provider specialty
2. Referral from specialist to cardiac catheterization
 - a. ICD-9/ICD-10 diagnosis of coronary disease (as above)
 - b. Date of service
 - c. Treatment location
 - d. Provider specialty
 - e. Referring doctor specialty

ICD International Statistical Classification of Diseases and Related Health Problems

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