Mortality in Coronary Artery Bypass Grafting
What’s Next?

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Over the past 48 years, coronary artery bypass grafting (CABG) has been among the most studied procedures in all of medicine. In part, this has been because CABG is a high-volume, high-cost intervention for ischemic heart disease. But, in addition to this, CABG is associated with an easily identifiable outcome that occurs with sufficient frequency to be of substantial interest to both providers and patients, namely, procedural mortality. The initial link between CABG and mortality was from the left main coronary artery subset of the Coronary Artery Surgery Study (CASS), which interestingly only included 150 patients.1

The development and widespread adoption of the Society of Thoracic Surgeons National Adult Database,2 the Northern New England Consortium,3 and other regional databases such as the New York State Cardiac Surgery Reporting System (CSRS),4 Michigan Society of Thoracic Surgeons,5 and Virginia Cardiac Surgery Quality Initiative6 have provided major refinements to our understanding of the impact of coronary bypass grafting on short-term (in-hospital and/or 30-day) mortality. Over the past 20 years, the risk-adjusted (RA) mortality related to CABG has declined, through a combination of process improvement2,7,8 and regional and national system intervention.9,10 According to the Society of Thoracic Surgeons National Database 2008 risk model, the short-term RA mortality for CABG has been oscillating at approximately 2% for the past 3 years.9

The weight of importance of short-term RA mortality as an outcome for CABG is reflected in its use as a National Quality Forum quality metric,10 in ranking hospital performance,11 and in public reporting.12 However, closer inspection of these Society of Thoracic Surgeons data demonstrate that over the past 3 years, the short-term mortality for isolated CABG has not continued the downward trend that characterized the prior 20-year interval.9 Although the cause for this is certainly multifactorial, its occurrence raises several important questions regarding short-term RA mortality as an outcome metric in CABG. At 2% or less, is the RA mortality frequency now insufficient for the metric to be an outcome discriminator?

Into this milieu the group from New York State have introduced a new and important attribute to mortality as an outcome metric in CABG.13 Their study, published in this issue of Circulation, analyzed the New York State CSRS registry and examined the long-term outcomes of patients who underwent coronary revascularization between July and December 2000. They then matched these patients to the Social Security National Death Index database and used this matched data set to create a Cox proportional hazards risk model to predict 3-, 5-, and 7-year late outcomes. The statistical performance of this model is robust, with a C statistic of 0.768, 0.769, 0.771, and 0.783 for mortality at 1, 3, 5, and 7 years of follow-up, respectively.

Of interest, the long-term prediction model performed better statistically than simple application of the New York State short-term mortality model4 to long-term outcomes, something that other investigators have attempted. Moreover, the initial presentation of this work excluded operative mortality, but at the suggestion of the reviewers, the operative mortality was included in the published Cox proportional model presented here.13 The 1-, 3-, 5-, and 7-year mortality rates were 1.5%, 9.3%, 15.8%, and 22.6%, respectively, excluding operative mortality, compared with 6.2%, 11.2%, 17.6%, and 24.2% when operative mortality was included. This comparison suggests that mortality after CABG over time is decreasingly dependent on the operation but rather consistently dependent on other factors.

Many of these factors appear in the Cox proportional hazards model. Patient age, body mass index, ejection fraction, unstable hemodynamic state or shock, left main coronary disease, cerebral vascular disease, peripheral arterial disease, congestive heart failure, latent ventricular arrhythmia, chronic obstructive pulmonary disease, diabetes, renal failure, and a history of open heart surgery contributed to long-term mortality. Not surprisingly, many of these are chronic disease processes or are manifestations of chronic disease processes.

It actually is of interest that the New York State late mortality model performs as well as it does. Because the Social Security National Death Index data do not discriminate between cardiac death and noncardiac death, there are a certain percentage of noncardiac deaths included in the model prediction. In the present analysis,13 other noncardiovascular diseases such as cancer or degenerative neurological disease appear to have relatively small effects on long-term outcomes. However, this lack of comprehensiveness should be identified as a potential limitation of this model when applied to other populations of interest.
because it is conceivable that the incidence of these noncardiovascular diseases might vary from region to region and from data set to data set.

One other interesting aspect of the statistical approach and model performance in the present study relates to the stability of the predictive model over time. One could argue that this is caused in part by a stabilizing effect on mortality afforded by successful revascularization. That is, the chronic disease risk factors that patients bring to surgery continue to determine long-term survival in part because the cardiovascular influence on mortality has been removed or ameliorated, at least within this 7-year time frame.

The interesting prospect of predicting long-term outcomes from CABG intervention for ischemic heart disease is but one of several new roles for mortality outcomes in this setting. For example, one interpretation of the stable short-term RA mortality trend data is that improvements could be made to the current observed/expected ratio methodology used to express mortality outcomes. From a patient-specific perspective, a mortality outlier would be characterized by a disconnect between the individual patient observed mortality and the individual patient predicted risk. Identification and elimination of these outliers may be necessary to drive the short-term RA mortality much below its current level because of the probabilistic nature of healthcare delivery. At this level of frequency of mortality in CABG, the observed/expected methodology may not yield granular enough information to continue to drive outcome improvements as it has in the past. A second area in which long-term mortality outcomes have become increasingly important is in intervention for ischemic heart disease, and in particular in choosing among and between interventional strategies. In the cumulative 4-year results of the SYNTAX (SYNergy between PCI with TAXUS and cardiac surgery) trial, long-term mortality was statistically significantly different between anatomically driven CABG and percutaneous coronary intervention. In the FAME (Fractional flow reserve versus Angiography for Multivessel Evaluation) study, intermediate-term mortality was substantially less with functionally driven rather than anatomically driven PCI revascularization. Is intermediate/late mortality a signal to help explain why in SYNTAX there was a survival benefit between 2 anatomically driven revascularization strategies? Does anatomy-based CABG revascularization also somehow provide better long-term functional benefit than anatomy-based PCI revascularization? Would anatomy-based CABG mortality outcomes improve even further with a functional SYNTAX-based revascularization strategy? Each of these questions highlights new, different, and important roles for mortality in CABG revascularization; some of these will be addressed in the National Heart, Lung, and Blood Institute’s ISCHEMIA trial (International Study of Comparative Health Effectiveness with Medical and Invasive Approaches), set to begin this summer.

RA long-term mortality models, as highlighted in the present New York State CSRS study, emphasize the importance of assessing long-term outcomes after interventions for ischemic heart disease. The authors have also demonstrated that a specific long-term model, rather than application of the short-term model to long-term outcomes, is probably the more valid approach. Finally, the importance of the bedside tool might seem difficult to place into context now, but in the near future, this type of information will drive the discussions of the heart team and the shared decision-making processes for patients with ischemic heart disease and their families. A patient-centric approach in this shared decision context includes providing information such that patients can accurately assess the long-term versus short-term risks and benefits of alternative therapeutic interventions for ischemic heart disease, because this decision will be different for different patients. This New York State CSRS study is an important step forward in this process. This long-term perspective also opens the door for these new and equally interesting roles for mortality as a benchmark in revascularization for ischemic heart disease.

Disclosures

None.

References


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