Severe morbidity after coronary artery surgery

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In recent years there has been a growth of new strategies to treat patients with coronary artery disease. Coronary artery surgery continues to change, with a greater emphasis on arterial grafting, refinements in cardioplegia, increased use of measures to prevent atherosclerotic emboli, and the introduction of minimal invasive surgery with or without the use of cardiopulmonary bypass. Furthermore, the indications for coronary surgery are changing. Angioplasty with stent deployment is being used for flow-limiting lesions in all major arteries. Emergency coronary artery surgery in the setting of acute myocardial infarction is being replaced by thrombolysis and interventional cardiology techniques. Generally, catheter-based techniques are being used more widely for multivessel coronary artery disease. Coronary artery surgery remains the procedure of choice for patients with multivessel disease and impaired left ventricular function, for left main stem disease and for patients with diffuse disease, particularly diabetics. Against this background, the analysis of patient outcome is of interest to many people. Unfortunately, some agencies especially in the U.S.A. have been willing to use outcome measures punitively to control medical practice and costs. Outcome analysis becomes helpful only where it leads to improved patient care. There are at least four important outcomes to consider: mortality, morbidity, resource utilization and patient satisfaction. Those patient characteristics that constitute important risk factors will depend to some extent on the outcome of interest. Most studies have focused on mortality as an outcome.

In 1989 Parsonnet et al. described a model of risk stratification for patients undergoing adult cardiac surgery. Since that time several groups have reported refinement in the estimation of risk of coronary artery surgery. Edwards et al. developed risk models for isolated coronary artery bypass surgery based on the Society of Thoracic Surgeons National Cardiac Surgical Database. Data from more than 300,000 patients undergoing surgery from 1990 to 1994 were used in the development of risk models of operative mortality. Five validation techniques were used to determine the reliability of the risk models and all the models were found to predict operative mortality with accuracy in the population studies. Edwards et al. found that significant risk factors with an odds ratio of 1.5 or greater were reoperation coronary surgery, pre-operative intra-aortic balloon pump, dialysis-dependent renal failure, cerebrovascular accident, immunosuppressant drugs, cardiogenic shock, resuscitation, and emergency operation.

In 1992 Higgins et al. from the Cleveland Clinic reported a model to predict morbidity and mortality in coronary patients based on pre-operative risk factors. This model took into account events in the operating theatre, physiological measurements in the intensive care unit, and pre-operative factors. The model was based on data collected from 2793 patients and validated during a subsequent period in 2125 patients. The mortality rate in the population was 3.1% and the morbidity rate was 10.4%. The model assigned point values from 1 to 7 on the basis of the logistic regression coefficients. A score of less than 5 at the time of the admission to the intensive care unit predicted a risk of less than 1% for mortality and less than 5% for morbidity. Factors with a weight of 3 or more included previous surgery or angioplasty for peripheral vascular disease, age 70 or greater, a pre-operative serum creatinine level of 1.9 mg. dl⁻¹, a pre-operative albumin level of less than 3.5 mg. dl⁻¹, cardiopulmonary bypass time in excess of 160 minutes, and use of an intra-aortic balloon pump after cardiopulmonary bypass, a cardiac index of less than 2.11. min⁻¹. m⁻², central venous pressure of 17 mmHg and an arterial bicarbonate of less than 1.

More recently, Sergeant et al. studied the effect of patient procedural and surgical variables on early and late survival after isolated coronary artery surgery. This group looked at a consecutive series of 9600 patients who underwent coronary artery surgery in one institution between 1971 and 1992. Follow-up information was complete in an exceptional 99.9%. The authors performed a multivariate time-related analysis, studying the influences and inter-dependency of patient variables, including variations in details of the procedure. The unadjusted survival
rates at 1, 10, and 20 years were 97% 81% and 50%, respectively. Patients' variables that influence late survival were left ventricular function and cardiac and non-cardiac morbidity. The authors were particularly interested in the significance of arterial grafting. They found that late survival was modestly improved with the use of an arterial graft to a major vessel, preferably to the left anterior descending artery, except for patients with a limited life-expectancy. Differences in time-related survival with or without an arterial graft were not importantly affected by the left ventricular ejection fraction. Sergeant et al. could not identify a late beneficial or detrimental effect of the more extensive use of arterial grafts in multivessel disease.

A cautionary note should be struck when risk models developed in another continent are used. Bridgewater et al.[5] compared the ability of four different risk models to predict operative mortality after coronary artery surgery in two centres in the U.K. The authors concluded that there were important differences between the British and North American populations for coronary artery surgery and the North American algorithms were not useful for predicting mortality in the U.K.

Staat and colleagues[6] from Lyon have taken a different approach and focused on morbidity in a retrospective study of 679 patients during the year 1996 when the incidence of morbidity was 23% and the overall mortality was 2.5%. The fact that this study was not prospective is a deficiency, which is acknowledged by the authors. They identified eight risk factors that predicted the events which they chose as representative of significant morbidity. Using a receiver operator characteristics (ROC) curve, the area under the curve was 0.77 which is reasonable and in line with other similar studies. Although this study will be of use to the surgeons where it was developed, because of its retrospective nature and its relatively small database it will probably be of limited use to other groups.

Nevertheless, studies that focus on morbidity as opposed to mortality are needed, but should include an assessment of length of stay as a measure of resource utilization, and quality of life as an indicator of patient satisfaction. Such outcome measures are particularly important for deciding how to use limited health budgets wisely. It has been estimated that as much as 40% of the yearly hospital costs for coronary artery surgery are consumed by 10 to 15% of the patients who have serious complications after operation[7]. The clinical variables associated with increased resource utilization after operation may differ from those associated with mortality. There is evidence to suggest[8] that risk factors associated with in-hospital death reflect co-existing disease-specific variables, while factors associated with resource utilization include co-morbid illness. For example, mortality risk after coronary artery surgery is associated with disease-specific factors such as recent myocardial infarction and ejection fraction, whereas risk factors for increased resource utilization include co-morbidity such as peripheral vascular disease, renal failure, and chronic lung disease. In this way co-morbid conditions become important predictors of hospital costs, since they often predict prolonged stay in hospital.

There are now a number of models that take into account multiple factors and which predict the early and late survival after CABG. There is increasing evidence to suggest[8] that risk factors associated with mortality are not identical to those associated with morbidity. There is increasing evidence to suggest[8] that risk factors associated with mortality are not identical to those associated with morbidity. There is increasing evidence to suggest[8] that risk factors associated with mortality are not identical to those associated with morbidity. There is increasing evidence to suggest[8] that risk factors associated with mortality are not identical to those associated with morbidity.