SURGERY FOR ACQUIRED HEART DISEASE

EDITORIAL ON "CORONARY ARTERY BYPASS GRAFTING IN PATIENTS WITH AN EJECTION FRACTION OF TWENTY PERCENT OR LESS"

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Kaul and his coauthors [see page 1001] relate their experience with a group of patients having low ejection fractions on whom they performed coronary artery bypass grafting. Careful statistics document early and late survival, expressed as hazard probabilities. On the basis of these results, the authors attribute enhanced success to the use of a combination of antegrade and retrograde cardioplegia, performing fewer bypass grafts (shorter cross-clamp times), and the absence of preoperative ventricular arrhythmias as a primary indication for operation. The patients in their study had complex problems and had several different indications for operations. Simultaneous and independent events may have influenced outcome, independent of the factors identified. These include experience, change in operative technique, inadvertent changes in operative selection, and other factors that constitute risks inherent in all retrospective studies. As such, it is uncertain whether similar modifications in operative technique by other groups are likely to yield the same results. Nonetheless, this study stimulated me to think about operations on patients with low ejection fractions and to reexamine the issues inherent in such a designation and study focus.

Why focus on results in patients with low ejection fractions? Presumably, the answer is determined from studies indicating the high risk of operation juxtaposed against the poor outcomes in patients treated medically. To some extent, surgeons weigh

their technical expertise by survival in patients in whom the risk is high, are challenged by high risk, and are appropriately proud of good results. A low ejection fraction is generally assumed to be a surrogate for a bad heart. But is it really? Many patients with low ejection fractions have been observed for years with remarkably good functional capacity. Other patients with comparably low ejection fractions require intensive diuretic therapy and after-load reduction. Some patients are so profoundly ill that cardiac transplantation appears to be the only hope for survival.

The anatomic diagnosis of a "bad ventricle" is difficult. It may be quantitated as ejection fraction, summated reductions in chord length shortening, ventricular dilatation, or a ventricle that is poorly contracting on angiographic or radionuclide study. Bad ventricles are better defined by their functional capacity. Are symptoms of congestive heart failure present? What is the maximum oxygen consumption under conditions of stress? What are the pharmacologic requirements of the patient to achieve reasonably comfortable day-to-day activities? How high are the filling pressures and how low is the cardiac index? Given such a complex of parameters that describe ventricular quality, it is not surprising that ejection fraction alone is a poor predictor of mortality in any given patient. Perhaps this is borne out in the Parsonnet scoring system and in the database of the Society of Thoracic Surgeons. Predictors of risk at the highest level consistently overestimate the actual risk (observed/expected <1). Kaul and his colleagues wisely selected patients presumed to potentially benefit from operation. A requirement for inclusion in their operative program was that the patient have evidence of reversible ischemia. This served as an "improvable element" in the constellation of risk predictors in patients with low ejection fraction but otherwise undefinable risk predictors.

Enhanced understanding of the factors that deter-

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mine poor long-term outcome and good or bad surgical outcome is important. The number of hearts available for transplantation relative to the number of patients recommended for transplantation is diminishing. The medical management of congestive heart failure is improving. The historic quote of 5-year survivals of 20% to 30% is no longer accurate. The survival of patients referred but not receiving cardiac transplantation in the early Stanford heart transplantation experience was only about 10% after 6 months to 1 year. Such is not the case in contemporary cardiac transplantation programs. Patients who do not receive urgent transplantation or surgical intervention shortly after recommendation for transplantation have a 3- to 4-year survival that parallels that of patients successfully undergoing transplantation.¹ Recent studies have shown that with careful selection, subsets of patients referred for cardiac transplantation may undergo revascularization and have survivals that match those of patients having transplantation.²⁻⁴ What is lacking is a predictive scoring system that takes into account most of the parameters critical as descriptors of left ventricular performance. Ideally, this would include ischemic risk, end-diastolic volume, end-systolic volume, filling pressures, ejection fraction, cardiac index, and maximal oxygen consumption. I have not seen a large series that has used logistic regression analysis incorporating all of these parameters to determine which parameters constitute the most critical elements of operative risk or that combined parameters mathematically to evolve a risk score based on the important interactions between these critical risk elements.

Current techniques for assessing the success of operations focus on factors prevalent in patients with good outcomes. Similarly, factors that may have been responsible for bad outcomes are identified by statistical analysis of multiple parameters but rarely by evaluating exquisite details of individual operations. Such is the nature of contemporary mathematical inquiry, and great advances have occurred as a consequence of this approach. On the other hand, there may be some room for applying the technique of "failure analysis" in a highly reasoned fashion. This may appear, at first, to be a step backward. It demathematizes the process to make it feel more like one that occurs every week in most institutions at the surgical quality assurance conferences (also known as morbidity and mortality conferences). In such settings, a bad result is justified by quoting a predicted risk. That having been done, the events of the operation responsible for a less favorable outcome are reviewed as if the operation were an isolated event. The Federal Avia-

tion Administration does not determine factors associated with unsuccessful flights by crashing 747s, modifying their design, and crashing them again. Instead, detailed and painstaking analysis of every air mishap contributes to an understanding of factors that may produce an adverse outcome. Those factors are incorporated into new aircraft design and the human aspect taught to airplane crews. Review of the recent literature suggests that coronary artery bypass grafting in patients with low ejection fractions is not as high risk an environment as one might think. Confounding factors frequently play a role in adverse outcomes. Just as in aircraft disasters, it is frequently a constellation of several events "gone wrong" that results in mortality. Several studies have reported operations for management of coronary artery disease in patients with bad ventricles with mortality of 5% or less. In such an environment, does one learn more from the successes or from the failures?⁵⁻⁸

Why do patients with bad ventricles have worse survival results after operation than patients with good ventricles? Presumably, patients die if revascularization is incomplete, if there is a mishap during the operation, and if myocardial protective techniques are not excellent. Added to those obvious answers is the complex physiology that accompanies bad ventricles. Virtually all ventricles with low ejection fractions have undergone some degree of remodeling. Myocytes are exposed to abnormal stresses and hormonal stimulation, and they express alterations in phenotype. Regions of myocardium are thinned, scarred, dilated, and are accompanied by other regions of myocardium that are hypertrophied. Flow imbalances at the microcirculatory level exist. The high catecholamine environment of cardiopulmonary bypass, fluctuations in perfusion, uneven reperfusion, variable myocardial protection, and imbalances in loading conditions after cardiopulmonary bypass probably contribute to dysfunction. This is an area still ripe for new investigation.

Critical dissection of poor outcomes should occur even in the presence of the traditional crepe that may be hung before such operations. With an aged population and more patients surviving acute myocardial infarction, it is highly likely that the population of patients with bad ventricles will increase, and the mandate to increase operative success clearly exists.

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