phosphate (GTP) and extracellular Na^+ are known to regulate receptor affinity.[12,13] In addition, hypothermia, among other factors, could conceivably alter the affinity of the receptors reversibly in a way that would not be detected by our assay. Similarly, we are unable to exclude the possibility of an agonist-induced change in affinity of the receptor that might have inhibited receptor cycling and that would have been reversed by washing off the agonist. In any event, the evidence suggests that there is no acute down-regulation or irreversible alteration of α-adrenergic receptors in platelets during cardiopulmonary bypass.

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Elective Coronary Bypass Surgery without Pulmonary Artery Catheter Monitoring

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Increasing concern over the cost of medical care has prompted reexamination of the indications for many clinical procedures, including pulmonary artery catheterization for hemodynamic monitoring. Recently Loop *et al.*[1] reported that one of the principal techniques employed at the Cleveland Clinic to contain the cost of coronary artery bypass graft (CABG) surgery has been to limit the use of the pulmonary artery (PA) catheter to patients with severely impaired left-ventricular function. The authors presented no data to support their limited use of the PA catheter.

The indications for PA catheterization in coronary artery surgery have been debated for several years.[2,3] Mangano[4] found that the PA catheter offered little advantage over the central venous (CV) catheter in managing CABG patients with ejection fractions greater than 50% and without angiographically demonstrable ventricular dyssynergy preoperatively, because the CV and PA-occluded pressures were highly correlated. However, in similar pa-

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tients, Waller *et al.*[5] reported that 65% of "severe" hemodynamic abnormalities detected during anesthesia by PA catheter monitoring were not detected by changes in CV pressure. Kaplan and Wells[6] similarly found that 55% of patients who had myocardial ischemia develop intraoperatively had abnormal pulmonary artery-occluded waveforms as the only sign. These authors advocated insertion of PA catheters in most patients undergoing CABG, principally as a means to detect myocardial ischemia before electrocardiographic changes become evident. A question left unanswered by these and other physiologic investigations is whether having the additional capability of the PA catheter to detect myocardial ischemia early, to manage circulating blood volume more precisely, or to measure cardiac output will improve the outcome of selected, low-risk patients.

Anesthesiologists at our institution employ the PA catheter selectively during CABG surgery. Usually patients with "good" left ventricular (LV) function (*e.g.*, ejection fraction greater than 40–50%, absence of a history of congestive heart failure, and normal arterial blood pressure response to exercise testing) are monitored intraoperatively and postoperatively with CV rather than PA catheters. This provided us with an opportunity to review the coronary artery operations performed without a PA catheter to determine the mortality, the incidence of perioperative myocardial infarction, and the frequency of PA catheterization for postoperative management.

Methods

The Division of Cardiothoracic Surgery at our institution keeps extensive computerized records of all its patients, including data on preoperative cardiac catheterization, intraoperative management, intensive care unit (ICU) course, and postoperative outcome. The data base includes the largest value from samples of creatine phosphokinase MB fraction drawn from each patient upon arrival in the ICU, 6 h later, and again the next morning.

We identified the study group by searching the data base for all patients who had surgery during the calendar years 1981–1983 and met the following criteria: 1) isolated CABG operation; 2) elective operation; and 3) CV catheter (rather than PA catheter) intraoperative monitoring chosen by the anesthesiologist. Operations were considered to be elective if the patient did not require management in the intensive care or coronary care units immediately preoperatively. Patients arriving in the operating room with either a CV or a PA catheter already in place were excluded from the study. We verified the identification of the study group by cross-referencing against an independent computer data base of anesthetics and intraoperative monitoring maintained by the Department of Anesthesiology. We then searched the surgery data base again for patients who died, had perioperative myocardial necrosis, stayed in the ICU more than 3 days, or had PA catheterization performed postoperatively, and we reviewed their medical records.

TABLE 1. Ejection Fraction by Angiography

Ejection Fraction Range	Number of Patients
<40	4
40–49	49
50–59	122
60–69	206
70–79	149
>80	37
Not measured	131

One-sided confidence intervals for mortality and infarction rates were calculated, based on the exact binomial distribution. Sample sizes were estimated with the use of the normal approximation to the binomial with continuity correction.[7]

Results

We found 698 consecutive patients meeting the study criteria. (In comparison, during the same time period, 577 consecutive patients had elective, isolated coronary artery surgery with PA catheter monitoring, a PA catheter utilization rate of 45.3%). The study group included 591 men and 107 women. Patient age (mean ± standard deviation) was 58.3 ± 9.5 years, with a range of 28–82 years. In 121 patients (17.3%), left main coronary stenosis of more than 50% of luminal diameter was present. Fifteen patients (2.15%) were undergoing their second coronary bypass operation. The distribution of the angiographically determined ejection fractions is shown in table 1. The number of grafts placed at operation is shown in table 2.

There were five in-hospital deaths, a mortality of 0.72% (95% confidence that the population mortality is less than 1.51%). One patient died from intractable dysrhythmias and pump failure after weaning from cardiopulmonary bypass; all grafts were found to be patent at autopsy. The second intraoperative death resulted from an anaphylactoid reaction to protamine sulfate after an uneventful weaning from cardiopulmonary bypass. Pulmonary artery and left atrial monitoring was instituted by the surgeon through the open chest after the reaction began. Postoperative deaths resulted from sudden ventricular fibrillation in a patient who had been doing well, to hypovolemic shock, and to pneumonia and sepsis in a patient who had sustained a massive perioperative myocardial infarction.

Perioperative myocardial necrosis (defined as a maximum postoperative creatine phosphokinase MB fraction of more than 30 u/l) occurred in 22 (3.2%) of the patients,

TABLE 2. Coronary Grafts (distal anastamoses)

Number of Grafts Performed	Number of Operations
1	64
2	127
3	197
4	181
5	91
6	31
7	6
8	1

of whom eight (1.15%) sustained transmural infarction confirmed by either new Q waves on the electrocardiogram or (in one patient) by technetium pyrophosphate scan, while 17 patients (2.4%) suffered subendocardial or diffuse myocardial damage. There is 95% confidence that the transmural infarction rate in this population is less than 2.06%.

Pulmonary artery catheterization was performed postoperatively in 33 patients (4.7%). Reasons for PA catheterization were as follows: postoperative hemodynamic instability (17 patients), hemodynamic instability beginning intraoperatively (two patients), postoperative hemorrhage (five patients), perioperative myocardial infarction (two patients), coronary artery spasm (one patient), respiratory distress syndrome (one patient), and unknown reasons (five patients).

The ICU stay for the study group was 2.1 ± 0.9 days (range 1–13 days). Twenty-three patients stayed more than 3 days in the ICU.

DISCUSSION

A decision to employ CV rather than PA catheter monitoring limits the options for patient management only during relatively brief periods at the beginning and the end of the operation. While it is difficult to insert a PA catheter percutaneously during cardiac surgery, alternatives are available to the surgeon, should unexpected problems develop when the chest is open. Either a PA catheter can be rapidly threaded into the innominate vein through a stab wound in the chest wall[8,9] or else a combination of a left-atrial catheter, a surgically implanted pulmonary artery thermistor, and the (existing) CV catheter can be used to monitor left ventricular preload and cardiac output.[10–12]

If needed postoperatively, a PA catheter can be inserted percutaneously. In fact, only 4.7% of the study patients required PA catheterization for postoperative management. Thus, by not routinely inserting a PA catheter preoperatively, we avoided catheterization of 665 patients and saved an estimated $216,000 in hospital and professional fees over the 3-year period, not including the cost of the additional operating room time that would have been needed for PA catheterization.

Although our study group would be considered low risk in terms of ejection fraction (table 1), it has a considerable number of patients with extensive disease, as illustrated by the number of grafts placed (table 2) and the 17.3% prevalence of left main coronary stenosis. Our hospital mortality rate compares favorably with the mortality rate reported by the multicenter Coronary Artery Surgery Study[13] (CASS) for 1) elective CABG patients (1.7%); 2) patients with ejection fraction ≥50% (1.9%); 3) patients with LV end-diastolic pressure ≤12 mmHg (1.6%); and 4) patients with no history of congestive heart failure (1.6%). However, a mortality rate of 0.4% has been reported in one series of 500 patients[14] in whom PA catheters were virtually always used (personal communication with the author). Our incidence of perioperative myocardial infarction also compares favorably with the rate reported by the CASS in patients with preoperative LV end-diastolic pressure <14 mmHg (3.2%) or normal LV wall motion (4.5%).[15]

Since this study is retrospective, we cannot answer the question of whether using a PA catheter would have helped prevent the deaths, myocardial infarctions, and prolonged ICU stays that occurred. Furthermore, we cannot determine to what extent the cost savings from not using PA catheters may have been offset by the cost of not having the information that they could have provided. Lowenstein and Telpic[2] suggested that a prospective study would be the best way to resolve the controversy about the proper role of the PA catheter in coronary surgery. However, because the mortality and infarction rates in this low-risk population are already so low, it would be very difficult to demonstrate an improvement by a prospective study. Some simple examples illustrate this point. To detect a reduction in mortality from 1.5% to 0.75%, a prospective study designed to have a probability of less than 5% of a Type I error (*i.e.*, falsely finding a difference in outcome when there is none) and a 20% probability of a Type II error (failing to find a difference, if present) would require 3,361 patients in a control group and the same number in a PA catheter group.[7] Similarly, a study designed to detect a reduction in the perioperative infarction rate from 2.0 to 1.0% would require 2,512 patients in each group. An even larger study population would be necessary if one assumed a lower death or infarction rate in the control group, if one tried to detect lesser improvement in the outcome due to PA catheterization, or if one required a lower probability of Type I or Type II errors. No single cardiac surgery center in the United States has a sufficient patient population to randomize the necessary number of patients within a reasonable time period.

We conclude that a considerable cost savings and a low incidence of mortality, perioperative myocardial infarction, and prolonged intensive care unit stay can be attained in low-risk patients undergoing elective coronary artery surgery without preoperative PA catheterization. The question of whether an improvement in outcome can be achieved with PA monitoring cannot be answered from these data alone, and the large number of patients required probably precludes performing a prospective, randomized, controlled study.

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Chylothorax Following Celiac Plexus Block

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Neurolytic celiac plexus block is used to relieve intractable pain in selected cases.[1,2] While major complications are rare, many risks and potential problems can occur, including paraplegia.[3] In one series[4] weakness and/or numbness in the T-10 through L-2 distribution was the most common finding (8%), followed by lower chest pain, failure of ejaculation in men, postural hypotension, the sensation of warmth or fullness of a leg, and urinary difficulties. Additionally, aortic or inferior vena cava puncture, kidney puncture, pneumothorax, puncture of viscera, abscess or cyst, and subarachnoid or intravascular injection with attendant sequelae are recognized hazards of this technique.[5–8] We describe a previously unreported potentially serious complication of this therapy.

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Report of a Case

A 75-year-old man with a history of pancreatic carcinoma was referred to our Pain Clinic for assessment and management of abdominal pain of 3 months duration. The diagnosis of adenocarcinoma of the head of the pancreas was made 18 months previously, at which time obstructive symptoms were treated surgically by roux en y choledochoenterostomy. Postoperative medical management consisted of 5-