Con: Pulmonary Artery Catheters Are Not Routinely Indicated in Patients Undergoing Elective Abdominal Aortic Reconstruction

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IN THE PAST MONTH, I have had two patients suffer cardiac arrest as a direct result of pulmonary artery catheters (PACs). One occurred as a result of heart block during insertion, and the other occurred during catheter removal, presumably from pulmonary embolization of thrombus on the catheter. A few months before, another patient whose severe left ventricular dysfunction was managed with a PAC died on the fourth day following lower extremity revascularization after PA rupture. When confronted with a monitoring tool that has such risks, we should seek evidence that its use improves outcome in our patients. It is important to focus on patient outcome when evaluating new and existing technologies rather than intermediate variables, especially given the growing pressures for cost containment in the American health care system.

Various factors may result in changes in physician practice patterns. Properly performed randomized clinical trials, when published in the literature, may alter practice.1 The results of multiple studies may be synthesized using metaanalysis.2 Increasingly, the federal government has sponsored expert panels to try to develop practice guidelines, such as those developed for the treatment of acute pain.3 Recently, the American Society of Anesthesiologists has published guidelines for the perioperative use of pulmonary artery catheters by anesthesiologists.4

It also appears that reimbursement patterns5 and physician availability6 affect how services are provided. Whereas previous reimbursement patterns may have encouraged the use of PACs by anesthesiologists, future reimbursement formulas may pay a fixed amount for a patient’s anesthetic care, or even for his or her entire hospitalization. Reimbursement schemes that are not based on time or the complexity of monitoring may result in decreased numbers of PACs inserted by anesthesiologists. Would patients suffer as a result? In most cases, I suspect not.

It is my impression that over the past decade the preparation of patients coming to the operating room for aortic reconstruction has improved. These improvements are multifactorial and include improved and more widespread antianginal and antihypertensive therapy, more precise preoperative risk assessment by noninvasive testing, and preoperative myocardial revascularization in those with the highest cardiac risk. Cardiac management has improved to the point where cardiac complications may no longer be the leading cause of death in surgical patients with coronary disease.7 Successful therapy of chronic hypertension results in a more stable induction of general anesthesia, presumably by increasing plasma volume8 and reducing left ventricular hypertrophy.9 Such improvements in preoperative preparation and pharmacologic therapy make it difficult to use historical controls to prove that PACs improve outcome, as purported by Rao et al.10

In addition to improvements in preoperative therapy, preoperative cardiac assessment is more common in my practice. This evaluation typically consists of standard echocardiography to document left ventricular function and may include dipyridamole thallium scanning (DTS) or dobutamine stress echocardiography (DSE) as a screening device for coronary artery disease. For these last two tests, there is a significant literature suggesting that patients with normal tests have very low rates of perioperative cardiac morbidity or mortality. Before entering the operating room, then, we have already identified a subset of patients (albeit it at a cost higher than that of a PAC, but with less risk) in whom the risk of a perioperative cardiac event is low (1.6% in patients with a normal dipyridamole thallium scanning11 and 0% in those with a normal dobutamine echocardiogram12) and in whom the risk/benefit ratio of PA catheterization is presumably higher. In the 1990s, PA catheterization should be limited to those at highest risk, or to those about whose cardiac reserve little is known.

Cardiac evaluation before abdominal aortic reconstructive (AAR) surgery may detect coronary artery disease amenable to treatment by PTCA or CABG surgery. Preoperative coronary revascularization, in selected patients, improves long-term survival after vascular surgery.13 Most studies have also suggested relatively low rates of perioperative cardiac morbidity after noncardiac surgery in patients with recent myocardial revascularization.14,15 One presumes that many patients in Attia et al’s16 famous study documenting cardiac decompensation at the time of temporary aortic occlusion (“cross-clamping”) would, in the 1980s, have undergone myocardial revascularization before AAR surgery. Even in patients at highest risk, however, there is little in the literature to conclusively persuade me that PA catheterization will benefit my patients.

The complications of pulmonary artery catheterization are legion and well known.17 The most common include arrhythmias, arterial damage, endocardial and valvular damage, pulmonary infarct, pulmonary hemorrhage, catheter knotting, and line sepsis. These complications probably occur less frequently, and the risk/benefit ratio is probably lower in environments where the use of PACs is common. No matter how skillfully and at low risk the catheter is placed, if the intensive care environment is not one in which the information is used effectively and in which dangers (such as a wedged PA trace) are quickly recognized, then the risks are magnified.18 I have shown that many clinicians are not skillful in interpreting the result of PA catheterization, potentially resulting in inappropriate interventions. In this study, the frequency of physicians’ use of

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PA catheterization and medical school affiliation of the physician's hospital predicted correct interpretation of hemodynamic data. Indeed, one study (albeit flawed in its randomization as are most studies in this area) suggests that patients with acute myocardial infarction who are managed with PACs have worse outcome.19

Can we get the same information that PACs provide at less risk and expense? It appears that in 90% of patients, changes in the CVP accurately reflect changes in PCWP.20 This should not be surprising; with infrarenal aortic occlusion, which occurs during the majority of these cases, left ventricular21 and right ventricular22 function are generally well maintained. Recent work suggests that simple observation of the fall in pulse amplitude with a Valsalva maneuver can predict PCWP.71 Whereas some authors have written that PAC-guided nitrate therapy and fluid loading improve outcome after AAR surgery compared to historical controls,24 it is not difficult to administer prophylactic nitroglycerin to patients who do not have a PAC.

Proponents of PACs argue that they can provide extensive physiologic information. In addition to the measurement of cardiac output and PCWP, the oxygen saturation of mixed venous blood (SVO2) drawn from the pulmonary artery reflects the adequacy of oxygen delivery to the tissues. Recent advances in technology have allowed for continuous monitoring of SVO2. However, simply drawing venous gases from a central line (ScO2) may also provide useful information,25 although differences between the values of SVO2 and ScO2 saturation in one study were greater than or equal to 5% during half of measurements. Good correlations were obtained between changes in SVO2 and ScO2 during periods without (r = 0.70) and with therapeutic interventions (r = 0.77).26

For patients who may require cardiac pacing, the insertion of a PA catheter with pacing capability may be warranted. However, even in cardiac surgery, routine placement is unwarranted because the significant predictors for the use or need for pacing catheters are few and include sinus node dysfunction/bradyarrhythmias, a history of transient complete atioventricular block, aortic stenosis, aortic insufficiency, and cardiac reoperation.27 In this large series (600 patients), PACs with pacing capability were used to pace only 6% of patients, in only 1% of patients without pacing PACs was cardiac pacing needed prior to cardiopulmonary bypass. One presumes that the need for pacing is even lower in patients undergoing AAR surgery, and that therefore the ability to pace the heart is not a reason to insert a PA catheter in the vast majority of AAR patients. Indeed, in patients with bifascicular block, PA catheterization may produce complete heart block.78

Despite early studies promoting the use of PAC for detecting myocardial ischemia,29 subsequent research has called this practice into question.30 31 Automated monitoring of the ST segments of the electrocardiogram probably represents a far simpler and safer way of detecting myocardial ischemia in surgical patients.32 ST segment analysis also provides the clinician with prognostic information regarding the likelihood of perioperative and long term cardiac morbidity and mortality.

In my practice, we frequently use transesophageal echocardiography to monitor patients during AAR surgery. Whereas this modality has several limitations, including expense, the need for training, possible diversion from other aspects of anesthetic management, and the lack of monitoring in the postoperative period, it also offers advantages. These advantages probably include safety, and superior measurement of left ventricular preload over PCWP measurement.33 Doppler technologies also allow estimation of left atrial pressure and cardiac output using TEE.34

Despite several trials that purport to demonstrate reductions in operative morbidity and mortality rates with PAC, routine use of invasive monitoring has not achieved widespread acceptance. This probably comes from the known complications of the PAC along with skepticism about the validity of some of the studies. Many of the studies use historical controls and do not have adequate randomization. However, two properly randomized studies in stable AAR patients have not shown benefits to PAC placement.35 In a study of 102 patients without uncompensated renal disease (BUN > 60 mg/dL) or cardiac disease (severe inoperable coronary artery disease, cor pulmonale, uncompensated congestive heart failure, cardiomyopathy, ejection fraction <40%, or symptomatic valvular heart disease), PAC had no effect on patient outcome.36 However, anesthesiologist professional charges were approximately $200 higher for patients who received PACs. In this study, it is important to note that 65 patients were not studied due to coexisting disease. It is possible that PAC use would be of greater value in this higher risk group.

In the American Society of Anesthesiologists' recently published practice guidelines on PAC use by anesthesiologists, the authors conclude that "PAC monitoring of selected surgical patients can reduce the incidence of perioperative complications." Yet, they go on to state that "due to deficiencies in the evidence, it is difficult to draw meaningful conclusions about the effectiveness or safety of PA catheterization based on currently available data. . . . The task force believes that benefits have not been demonstrated in currently available research because most of these outcomes have not been properly evaluated."37

Despite the lack of conclusive evidence, it is my current practice to place PACs in patients undergoing AAR surgery who have chronic renal insufficiency (creatinine >3.0 mg/dL), left ventricular dysfunction (ejection fraction <30% to 40%), recent history of congestive heart failure, insulin-dependent diabetes with end-organ complications, a supra-renal cross-clamp applied, valvular heart disease, and those with severe coronary artery disease (documented usually by DTS or DSE) in whom coronary revascularization has not been performed. Such patients represent approximately one third of the patients I anesthetize for AAR surgery. I usually place a sheath introducer in the right internal jugular vein, which allows for rapid volume administration during surgery, and for placement of a PAC later should I or the clinicians caring for the patient in the
ICU desire one. However, our experience has been that PACs are rarely placed subsequently, even with the availability of an introducer; Tuman et al found similar results in patients undergoing coronary bypass graft surgery. Recent additions to PAC have expanded the monitoring of critically ill patients. The ability to monitor right ventricular ejection fraction and continuous monitoring of cardiac output or SVO₂ may hasten detection and treatment of hemodynamic or oxygen transport abnormalities. However, at least one study addressing the use of oximetric PACs demonstrated no benefit over CVP monitoring or the use of conventional PACs during cardiac surgery. Given the risks involved with PAC, the changing reimbursement climate and the paucity of evidence suggesting improved outcome from routine use of PACs in AAR surgery, I suggest that our attention instead be directed towards prophylactic approaches that may minimize cardiac and other organ morbidity. Prophylactic approaches may include the use of regional anesthetic techniques (usually in conjunction with general anesthesia), the use of high doses of narcotics, and the use of α₂-agonists. For example, Reiz et al demonstrated that the use of combined general-epidural anesthesia reduced the incidence of elevations of pulmonary capillary wedge pressure to greater than 18 mmHg during AAR surgery from 73% to 17%. In addition, patients who received epidural anesthesia with local anesthetics had lower indices of myocardial oxygen demand and less myocardial ischemia as detected by the V5 lead of the ECG. In a series of 100 patients undergoing aortic reconstruction, Roizen et al found that elevated catecholamine levels were associated with an increased incidence of renal dysfunction; a high-dose sufentanil anesthetic tended to be more effective at reducing catecholamine levels. The suppression of the perioperative sympathetic response with sufentanil was also associated with less postoperative congestive heart failure. Another approach to sympatholysis is the use of clonidine, which can significantly attenuate the endocrine surge and elevated metabolic rate that typically follow AAR surgery, diminishing the need for intervention to treat hypertension. Flacke et al found that clonidine premedication increased cardiac output and lowered systemic vascular resistance after coronary bypass surgery compared to control.

Shoemaker et al have suggested that using PACs to guide therapy to produce supranormal oxygen delivery decreases mortality in surgical ICU patients. However, merely monitoring hemodynamics with PACs did not improve outcome in this study. Whereas such a strategy may be useful in the patient with sepsis and multi-system organ failure, I would rather suppress postoperative increases in oxygen consumption than make a compromised heart work harder. Indeed, Berlauk et al, who used preoperative PACs to guide hemodynamic optimization, produced two postoperative myocardial infarctions in the process. I prefer to use anesthetic and sympathetic techniques to blunt the adrenergic response to surgery and pain rather than wait to start a nitroglycerin infusion once the PA pressures inevitably rise.

I believe that two other tasks deserve more attention from the anesthesiologist caring for the patient undergoing AAR surgery than does routine PAC use: aggressive attempts at heat conservation, and when appropriate, extubation of patients at the end of surgery. Postoperative hypothermia may precipitate shivering and appears to be associated with myocardial ischemia. Myocardial ischemia occurs frequently around the time of emergence, and the anesthesiologist must be as vigilant during emergence as during induction. Exubation in the operating room is facilitated by normothermia and aggressive use of nitroglycerin and β-adrenergic blocking drugs. One does not need a PAC to know that the hypertension accompanying surgical stimulation, tracheal suctioning, or extubation is usually associated with acute pulmonary hypertension, which is amenable to treatment with nitrates.

In summary, preoperative evaluation allows identification of high-risk AAR patients who might benefit from PAC placement. Despite the beliefs of some clinicians, however, there is little conclusive evidence to demonstrate that this practice improves outcome. PACs should not be used routinely in AAR patients. Rather, our efforts should be focused on blunting the adrenergic response to surgery, particularly in the postoperative period.

REFERENCES

10. Rao TL, Jacobs KH, El-Etr AA: Reinfarction following...


