

## INTRAOPERATIVE STRATEGIES FOR REDUCING PERIOPERATIVE RISK

### Anesthetic Management

Epidural anesthesia and analgesia may improve the outcome of major noncardiac surgery through better suppression of surgical stress, a positive effect on postoperative nitrogen balance, more stable cardiovascular hemodynamic response, reduced blood loss, better peripheral vascular circulation, and better postoperative pain control. Overall, there is no preferred myocardium-protective agent, and decisions about anesthetic management should be part of a multidisciplinary effort led by an anesthesiologist. Whereas neuraxial anesthesia (epidural and spinal) may reduce pulmonary and thrombotic complications, its role in lowering cardiac complications is unclear. A technique of combined neuraxial blockade and general anesthesia has merit when indicated to reduce the intraoperative general anesthesia requirements.

Studies have demonstrated that pain management in the perioperative period is crucial for reducing cardiac risk. Adequate pain control reduces catecholamine surges, which are probably responsible for increased myocardial oxygen demand, induction of coronary vasospasm, increased tendency for plaque rupture, and development of a hypercoagulable state.

### Intraoperative Pulmonary Artery Catheter

The current evidence on whether the use of a pulmonary artery catheter (PAC) is beneficial for high-risk patients undergoing major noncardiac surgery is controversial. Catheter-guided volume optimization has no clear benefit perioperatively. In a large multicenter randomized trial, Sandham and associates found no benefit for therapy directed by a PAC compared with standard care in elderly, high-risk surgical patients. Nonetheless, a PAC may be considered for patients with signs and symptoms of heart failure preoperatively, who have a very high postoperative incidence of heart failure, and for high-risk patients with limited ventricular reserve who are undergoing procedures that are likely to cause major hemodynamic shifts. Guideline recommendations advocate for evaluation of three parameters—patient disease, surgical procedure (and anticipated intraoperative and postoperative fluid shifts), and practice setting (experience in PAC use)—when considering the intraoperative and postoperative use of a PAC. Regarding practice setting, there is variability in provider understanding of invasive hemodynamic data, and incorrect interpretation of data from a PAC may lead to harm.

### Intraoperative Transesophageal Echocardiography

Because ischemia-induced myocardial wall motion abnormalities appear earlier than ischemia-induced electric abnormalities, intraoperative transesophageal echocardiography (TEE) was proposed to be a more sensitive monitor of ischemia than conventional intraoperative 2-lead ECG. Similarly, 12-lead ECG monitoring was also proposed to have greater sensitivity than conventional intraoperative ECG. However, a comparison of intraoperative monitoring using 2-lead ECG versus routine monitoring for myocardial ischemia with TEE or 12-lead ECG during noncardiac surgery failed to provide robust evidence for

incremental value in identifying patients at high risk for perioperative ischemic outcomes. Therefore, the routine use of intraoperative TEE is not recommended for monitoring and guiding therapy during noncardiac surgery, except in emergent scenarios in which the cause of an acute persistent and life-threatening hemodynamic instability needs to be determined.

### Maintenance of Body Temperature during Noncardiac Surgery

Current ACC/AHA guidelines recommend maintenance of the patient's body temperature in a normothermic range rather than use of hypothermia to provide organ protection during surgical procedures. A retrospective analysis of a prospective randomized controlled trial demonstrated that hypothermia (core temperature  $<35^{\circ}\text{C}$ ) was associated with an increased risk for myocardial ischemia compared with a core temperature greater than or equal to  $35^{\circ}\text{C}$ . A randomized controlled trial involving 300 high-risk patients undergoing noncardiac surgery in which patients were randomized to active warming or routine care demonstrated that adverse cardiac events (unstable angina, myocardial ischemia, cardiac arrest, and MI) occurred less frequently in the normothermic group than in the hypothermic group (1.4% versus 6.3%;  $P = .02$ ). Furthermore, hypothermia was an independent predictor of adverse cardiac events by multivariable analysis (RR, 2.2; 95% CI, 1.1 to 4.7;  $P = .04$ ), indicating a 55% reduction in risk when normothermia was maintained.

## POSTOPERATIVE CARDIAC RISK ASSESSMENT

### Monitoring for Myocardial Infarction

Although there are no standard criteria for their diagnosis, most perioperative MIs occur within the first 3 days after noncardiac surgery. A protocol involving ECG evaluation immediately after surgery and on postoperative days 1 and 2 has the highest sensitivity for detection of postoperative MI; routine serial measurements of creatine kinase and its CK-MB fraction led to high false-positive rates and did not increase the sensitivity. Myocardium-specific biomarkers such as troponin I and troponin T have emerged as the most sensitive and specific biochemical markers of myocardial injury and infarction and have been associated with increased risk for cardiac events if elevated in the postoperative period.

While EKG is recommended in the setting of signs or symptoms suggestive of myocardial ischemia, MI, or arrhythmia in the postoperative period, the usefulness of postoperative screening with ECGs is uncertain. Measurement of cardiac biomarkers should be reserved for patients at high risk and for those who demonstrate ECG changes, angina typical of acute coronary syndrome, or hemodynamic evidence of cardiovascular dysfunction.

### Postoperative Risk Stratification and Management Strategies

Postoperative patient care involves assessment and treatment of modifiable cardiac risk factors, including hypertension, hyperlipidemia, smoking, obesity, hyperglycemia, and physical inactivity. Patients who sustain a perioperative MI or develop evidence of myocardial ischemia should be carefully investigated because

