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In Reply:—The thoughtful comments of Daly and Seravalli provide an opportunity for me to correct their misunderstanding of my article. I articulated several reasons why I believe it is generally in the best interest of both patients and their physicians to suspend do-not-resuscitate (DNR)-orders during anesthesia and surgery. Nevertheless, "with the increasing recognition of the autonomy of the competent patient in medical decision-making, it would be inappropriate not to seek the patient's guidance and provide as much latitude as possible within the constraints of the physician's own ethical standards." I specifically rejected the increasingly common practice of making the suspension of DNR orders during anesthesia and surgery a matter of hospital policy.

The Children's Hospital of Boston is currently considering a more flexible policy, as follows, that reflects these points and further illustrates my position.

Mandatory Reassessment of DNR Orders before Anesthesia and Surgery

Patients with DNR orders may be appropriate candidates for anesthesia and surgery, often for procedures intended to facilitate care or relieve pain. The etiologies and outcomes of cardiopulmonary arrest during anesthesia are sufficiently different from those in nonsurgical settings that reevaluation of the DNR order is always necessary. The fact that cardiopulmonary arrest is more likely to be reversible when it occurs during anesthesia will often mean that it is in the patient's best interest to have the DNR order suspended during the intraoperative and immediate postoperative periods. In addition, since the administration of anesthesia almost always involves some degree of resuscitation, many anesthesiologists believe that DNR orders are inherently incompatible with the practice of anesthesiology.

For some patients, however, suspension of a DNR order during surgery and the immediate postoperative period may not be in their best interest. In addition, there may be some patients who do not want to be resuscitated under any circumstances. Anesthesiologists must decide on an individual basis whether they are willing to provide care under these circumstances.

Therefore, it is the responsibility of the anesthesiologist, in conjunction with the attending physician, to discuss these issues with the patient and/or family to determine whether the DNR order should be suspended during anesthesia and surgery. If the patient elects to have the DNR order suspended, the anesthesiologist should inform the patient's surgeon, document the decision in the medical record, and convey the decision to those who will be involved with the patient's care during the intraoperative and immediate postoperative period. The anesthesiologist must also coordinate with the patient's caregivers and document in the medical record the time when the DNR order is to be reinstated.

If the patient elects to have the DNR order remain in effect, the anesthesiologist and any other caregivers have the option of declining to participate in the case. Should the anesthesiologist decline to participate, he or she must make every reasonable effort to find an anesthesiologist who is willing to treat the patient.

The anesthesiologist should discuss with the patient which interventions will be undertaken in the event of a cardiopulmonary arrest, and document both the discussion and the specific interventions in the medical record. Explicit agreement must be reached concerning the use of chest compressions, endotracheal intubation, mechanical ventilation, and vasopressors. In addition, if regional anesthesia is to be used, the circumstances (if any) under which the above interventions will be performed must be clearly documented in the medical record.

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Pressure–Rate Quotient in Patients Undergoing Coronary Artery Bypass Graft Surgery

To the Editor:—In their recent study,[1] Gordon and co-workers evaluated the ability of the pressure–rate quotient (PRQ = mean arterial pressure/heart rate) to predict or to indicate myocardial ischemia in a population of 60 patients undergoing elective coronary artery bypass graft surgery. They concluded that the PRQ is a poor predictor.

The PRQ concept was developed in a canine model of myocardial ischemia produced by a rigid coronary stenosis[2] and is likely best applied in patients with stable, nondynamic coronary lesions. A proportion of Gordon *et al.*'s subjects may have been outside this category: four of the nine patients with ischemic episodes had ischemia on arrival in the operating room, an indication of unstable coronary artery disease. Unstable angina is caused by dynamic events involving thrombus formation and coronary artery spasm at the site of a deteriorating atherosclerotic plaque.[3] These dynamic events cause primary reductions in coronary blood flow and "nonhemodynamic" ischemia. Since no hemodynamic index or value can predict ischemia in this subset of patients, the inclusion of such patients would bias Gordon *et al.*'s study toward negative results.

The conclusion that the PRQ is a poor predictor and indicator of intraoperative ischemia is based in large part on a strikingly low "positive predictive value," the likelihood that a PRQ less than 1.0 $mmHg \cdot min \cdot beat^{-1}$ is associated with ischemia. Despite acceptable sensitivity and specificity (85 and 91%, respectively) in the subjects with good left ventricular function, the low frequency of ischemia in association with a high false positive rate combined to produce a low positive predictive value.[4] I would argue that sensitivity and specificity are better tests of the PRQ concept than is positive predictive value; however, since a hit (true positive indicating ischemia) is of more clinical importance than a miss (false positive). The authors' own data (their Fig. 6) show that ischemia decreased as PRQ increased. This finding

supports the time-honored clinical strategy of maintaining a normal arterial blood pressure with a normal to low heart rate during anesthesia in patients with coronary artery disease.

The authors carefully determined whether a criterion value for PRQ other than 1.0 mmHg · min · beat^{-1} was a better predictor of ischemia. This strategy certainly makes sense because the original study in dogs[2] was done with a uniform stenosis and because patients come to surgery with lesions of varying severity. Unpublished studies from my laboratory demonstrate that ischemia occurs at a PRQ less than 1.0 mmHg · min · beat^{-1} with a less severe stenosis and at a PRQ greater than 1.0 mmHg · min · beat^{-1} with a more severe stenosis than that used in the original study.[3] Because stenosis severity probably varied in Gordon *et al.*'s patients, no single PRQ value would be expected to define an ischemic threshold for the entire population, yet a threshold might well be defined in each subject. The PRQ concept predicts that ischemia should lessen if blood pressure and heart rate are adjusted to increase PRQ, but this intervention has not yet been tested in individual patients.

The PRQ concept certainly has limitations, many of which were discussed in the original publication.[3] The concept is best suited to patients with good left ventricular function who have stable coronary lesions. That the PRQ fared as well as it did in Gordon *et al.*'s diverse population is remarkable.

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In Reply:—Dr. Buffington raises questions regarding data from our study, which was based upon his original investigation.[1] The four patients who came to the operating room with ischemia do not represent patients with unstable angina. These patients did not exhibit the hallmark of unstable angina: increased frequency and/or severity of anginal symptoms. Rather, these symptoms were similar in magnitude to their preoperative pattern.

The second issue Dr. Buffington raises is whether sensitivity and specificity are more relevant to clinical practice than is the positive predictive value. These indices are based on similar observations:

$$\text{Sensitivity} = TP/(TP + FN)$$

$$\text{Specificity} = TN/(TN + FP)$$

$$\text{Positive predictive value} = TP/(TP + FP)$$

$$\text{Negative predictive value} = TN/(TN + FN)$$

where TN = true negative; TP = true positive; FN = false negative; and FP = false positive.

We would argue that the predictive value is more meaningful to the clinician.[2] For a *given event,* the anesthesiologist wishes to know whether pressure–rate quotient (PRQ) < 1 predicts ischemia. In the clinical setting, even in patients with good left ventricular function, the positive predictive value was poor, despite an acceptable sensitivity. To put it another way: when the PRQ is *greater than 1,* ischemia is unlikely (negative predictive value). In contrast, if PRQ < 1, there is only a small likelihood that ischemia is present. We believe that the graphic representation of our data supports our conclusions. The relationship between myocardial ischemia (ECG) and different PRQ values is *inconsistent.*

The degree of coronary stenosis may affect the relevance of the PRQ concept. In a clinical setting, however, as Dr. Buffington states, dynamic constriction of the coronary arteries can occur. How well the "threshold" PRQ can predict ischemia remains to be defined. Two additional studies using ECG as the ischemia monitor also suggest that at various PRQs, ischemia could not be reliably predicted in patients.[3,4] Each report noted, as has Buffington, the difficulties in extrapolating data from an animal model to the patient with ischemic heart disease.

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