diac output. Moreover, lowered blood viscosity associated with anemia complements the increased cardiac output. Effects of decreased viscosity with low hematocrit values can result in a fivefold increase in coronary perfusion.12

Maximum myocardial oxygen transport shows an inverted U-shaped relationship with the hematocrit value.12 At extremely low or extremely high concentrations of red blood cells, myocardial oxygen transport may decrease due to decreased oxygen carrying capacity on the one hand and increased blood viscosity on the other. Thus, the peak of the above curve occurs at or slightly above the normal hematocrit level.13 Compensatory mechanisms to counteract the low hematocrit level include alterations in peripheral vascular resistance in order to redirect cardiac output to selective vascular beds, so that during anemia; the increasing blood flow is proportionally greater in the coronary bed than in the renal, mesenteric, or femoral beds.13 This phenomenon is owed to vasoconstriction or vasodilation because of neurohumoral and/or local autoregulatory factors.13 Also, in chronic anemia the red blood cells develop increased levels of 2,3-diphosphoglycerate, which facilitates release of oxygen from hemoglobin;14 however, this mechanism may be of secondary importance in severe anemia since the arteriovenous difference is decreased 3 volumes per 100 ml of blood, compared with 4 to 5 volumes per 100 ml of blood in normal subjects.11 Another important mechanism of increased oxygen delivery to the heart in pernicious anemia may be increased utilization of coronary collateral vessels.15 Release of local vasodilators may help improve collateral blood flow after development of severe anemia.

If these adaptation mechanisms in severe anemia do not compensate adequately, angina pectoris may develop in these patients in spite of normal coronary arteries. Angina pectoris caused by severe anemia usually develops at very low hemoglobin levels, in the range of 3 to 4 g/dl. Coombs16 noted an association between severe pernicious anemia and anginalike pain, especially on exertion. The true incidence of angina pectoris associated with pernicious anemia could not be determined accurately, since many of the patients reported did not have adequate studies of the coronary circulation to rule out associated coronary artery disease. Clinically, the incidence appears to be in the range of 2 to 3 percent.17 Although severe anemia is not a common cause of angina, it should always be listed in the differential diagnosis of angina pectoris.

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Assessment of Operative Risk in Patients Undergoing Lung Resection

Importance of Predicted Pulmonary Function

The incidence of lung cancer continues to increase in the United States as the cumulative effects of cigarette smoking are expressed. The common asso-
ciation of COPD with lung cancer complicates the decision to perform surgery, the only commonly curative treatment available for lung cancer. In making a decision to perform surgery, the pulmonary physician and the thoracic surgeon must assess the potential risks of the procedure versus the potential benefit.

Many risk factors have been identified over the years. The relative importance of these risk factors is debated. Preoperative diagnostic evaluation, surgical management, and postoperative care have improved in recent years. The elements of the decision-making process must, therefore, be continually reviewed.

In this issue of Chest, Kearney and associates (see page 753) review their experience with 331 patients who underwent lung resection at their hospital. Complications and mortality were examined in a prospective fashion. They found a very low incidence of both morbidity and mortality. The method of detection was by review of physician’s daily notes. The authors acknowledge that their detection method may have been less sensitive than methods used in other studies. They attribute their low mortality and morbidity to a relatively healthy population, careful preoperative management, and experience of the surgical team.

When examining predictors of postoperative complications in a univariate model, the authors confirmed observations of others in that age >60 years, male, history of cigarette smoking, type of procedure, and predicted postoperative FEV₁ were all significant predictors of surgical outcome. Of these, only predicted postoperative FEV₁, was a useful predictor of complications in a multivariate model. The authors use a simple calculation method for determining the predicted postoperative FEV₁ based on the preoperative FEV₁ and the number of lung segments removed or biopsied in the procedure. This is a simple modification of the technique reported by Wahi et al and is supported by a number of earlier authors.

The surprising findings included the observations that preoperative FEV₁ < 1 L, PCO₂ ≥ 45, oxygen desaturation during exercise, and current smoking status were not predictors of complications. The authors acknowledge the possibility that lack of power contributed to this; however, the effects of these risk factors on complication rates are so small that a much larger study would probably also lack sufficient power to resolve these differences.

Warner et al have found that preoperative smoking cessation did not appear to be beneficial prior to cardiac surgery. The current study expands this finding to noncardiac thoracic surgery. Since patients may quit smoking because of ill health, it would be a mistake to accept this notion unquestioningly. We cannot conclude that smoking cessation is not beneficial without a prospective preoperative smoking cessation study to address the issue.

The lack of predictive value of preoperative FEV₁ may reflect the current surgical practice. The authors limited the extent of surgical resection in patients with severely impaired function, although it appears that patients tolerated lobectomy surprisingly well. The lack of predictive value of a high PCO₂ and oxygen saturation may reflect the same standards of surgical practice, but are also rather surprising in comparison with other studies.

The authors conclude that the simple calculation used is adequately predictive of postoperative complications. If confirmed by other studies, this may have a significant impact on preoperative evaluation for patients with lung cancer and COPD. As we become more and more conscious of limited resources available for patient evaluation and management, we might restrict our use of radionuclide studies, and other methods for preoperative risk assessment, for patients with impaired pulmonary functions who require lung resection.

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REFERENCES