Predicting Postoperative Pulmonary Complications: The Sleeping Giant Stirs

Since the seminal article in 1977 about risk prediction of postoperative medical complications, the bulk of published research in this field has focused on cardiac complications (1, 2). Yet, mounting evidence indicates that pulmonary complications are as clinically important as cardiac complications in frequency, mortality, and length of hospital stay after various surgeries (2–4). With publication in this issue of the study by Arozullah and colleagues (5), the sleeping giant of risk prediction for postoperative pulmonary complications stirs.

To develop a risk index for predicting postoperative pneumonia, the investigators used data from the prospective cohort study of the Veterans Affairs National Surgical Quality Improvement Program (NSQIP) (6). The primary aim of the NSQIP was to develop models to adjust for severity of patients’ preoperative risk when assessing surgical quality of care, as determined by postoperative mortality and morbidity rates. Research nurses gathered data from diverse “medical record” sources (such as chart, computerized laboratory reports, operative report, anesthesia log, and discussion with care providers) and assessed patients directly only by telephone or letter 30 days after surgery. Primary outcome measures of the NSQIP were all-cause mortality and major postoperative complications within 30 days of surgery. Procedures associated with all types of anesthesia were included, and transplantations and operations with very low mortality rates were excluded. In addition, investigators limited eligible operations from high-volume centers to balance the data set with low-volume centers (6).

Arozullah and colleagues retrospectively used this ongoing Veterans Affairs database to assess incidence and determine predictors of postoperative pneumonia after noncardiac operations (5). The investigators further excluded patients who were ventilator dependent or had pneumonia before surgery, as well as those who had postoperative respiratory failure or unplanned intubation before pneumonia was diagnosed. Of note, Arozullah and colleagues reported separately on incidence and prediction of postoperative respiratory failure, using the same database and similar methods (7).

The investigators defined postoperative pneumonia according to criteria for nosocomial pneumonia from the Centers for Disease Control and Prevention. These criteria are based on physical examination or chest radiography plus change in the character of sputum or laboratory evidence of a pathologic organism and are not linked to administration of antibiotics. Patients enrolled in the latter half of the study (1997 to 1999) made up the data set for development of the risk model; data from patients enrolled in 1995 to 1997 were used to validate the model. Using standard, thorough techniques for logistic regression, the investigators developed and validated a model of 14 variables in risk for postoperative pneumonia and converted it to a simple scoring system, the postoperative pneumonia risk index. Accuracy of the risk index was good overall by statistical criteria (C-statistic of 0.817).

Arozullah and colleagues’ study has some limitations. Most important, it was a secondary analysis of data from a study designed to answer different questions, and the authors gathered outcome data through variations on the theme of medical record audit. Strictly requiring change in the character of sputum or bacteriologic evidence of pneumonia per the Centers for Disease Control and Prevention definition may have underestimated the overall incidence of pneumonia. Simultaneously, this criterion may have overestimated the rate of pneumonia in patients whom physicians perceived as sufficiently high risk that their thresholds for obtaining diagnostic studies for pneumonia were lower than for other patients.

In addition, the authors described complications associated with pneumonia (for example, respiratory failure, sepsis, and myocardial infarction) but did not tell us how many patients had only pneumonia and, for those with multiple complications, whether or not pneumonia was the index or first complication. Recent work suggests that a substantial minority of patients have multiple complications and a worse prognosis, but risk factors and prognosis have not been well studied in these patients (2, 3).

Nevertheless, Arozullah and colleagues’ study is a significant step forward in preoperative pulmonary risk assessment and helps us to establish priorities for future research. One of the most important contributions of
the study is its size; a major limitation of previous studies is small samples that limited our ability to examine a broad spectrum of plausible risk factors. Arozullah and colleagues’ findings add to a recent thorough review of previous studies (8). The following are consistent sentinel risk factors across different definitions of complications in different surgical populations: smoking status, chronic obstructive lung disease (defined by history or clinical examination); preoperative spirometry has not proven prognostically useful), measures of general health status (such as comorbid condition measures, functional status, and recent weight loss), cognitive impairment, previous stroke, and type of surgery. Age was also found to be a risk factor in this and previous studies, depending on how well the researchers controlled for comorbid conditions. Additional risks identified with this large study include long-term steroid use, recent moderate to heavy alcohol intake, impaired renal function, and large transfusions, all suggestive of depressed immune competence as a risk factor for pneumonia. Lack of data precluded analysis of several other potentially important variables, such as albumin level, spirometry, use of prophylactic antibiotics, and body mass index or obesity. However, previous studies have consistently suggested that spirometry, although diagnostically accurate, does not provide useful prognostic information and that obesity is not a significant risk factor for postoperative pulmonary complications (8).

Arozullah and colleagues’ study raises an ongoing issue in translating research into practice: clinical heterogeneity versus homogeneity. In contrast to many previous studies, these investigators opted for operative heterogeneity (multiple types of operations) coupled with outcome homogeneity (restricting the outcome of interest to postoperative pneumonia rather than a broader group of pulmonary complications). Although model accuracy overall is very good, the model might not perform as well for more homogeneous individual surgical subtypes, especially those in which the risk for pneumonia is relatively low.

What about the problem of outcome homogeneity—that is, restricting the outcome of interest to pneumonia? Among previous studies, definitions of postoperative pulmonary complications varied widely, were often not explicit, and sometimes included complications of little clinical significance (such as mild atelectasis or hypoxemia) or from a different pathophysiologic family (such as pulmonary embolism). Thus, refinement of the definition of pulmonary complications in this and recent studies to a narrower spectrum of clinically relevant and related outcomes is an improvement in the literature. What about further restriction to just one clinical entity, as Arozullah and colleagues have done? Does separating respiratory failure and pneumonia as outcomes help or hurt the accuracy of risk assessment? The authors’ previous report on predicting postoperative respiratory failure, using the same Veterans Affairs database and nearly identical methods, helps us sort through this potential problem (7). Of 14 independent predictors in the pneumonia risk index and 17 in the risk index for respiratory failure (not counting preoperative pneumonia and albumin level, which were excluded from consideration a priori for the pneumonia index), the two indices share 13 variables in common. Unique variables included steroid therapy for chronic conditions (pneumonia model) and preoperative renal failure, diabetes, dyspnea, and history of congestive heart failure (respiratory failure model). We have more to learn about the extent to which risk factors for clinically important atelectasis or exacerbation of underlying lung disease are the same as those for pneumonia and respiratory failure or if complication-specific risk indices will be more helpful.

Many previous studies have reported a higher risk for pulmonary complications with general anesthesia. This study adds to the weight of evidence favoring reduced risk with spinal or epidural anesthesia. However, this dichotomy may be too simplistic for modern anesthesiology. A recent systematic review of trials with randomization to intraoperative neuroaxial blockade or not suggests that we should shift the question from general versus spinal or epidural anesthesia to whether it is the presence, versus the absence, of neuroaxial blockade that confers benefit (9). In that review, neuroaxial blockade, alone or combined with general anesthesia, was associated with fewer deaths and complications. In a subgroup meta-analysis of general anesthesia alone versus neuroaxial blockade alone, general anesthesia was associated with a higher mortality rate. The increasing use of combined general and regional techniques for surgery plus postoperative epidural analgesia may blur any distinction and make moot the “pure” question of general versus spinal anesthesia. In the meantime, the relative safety
of each technique alone may remain substantially determined by practitioner skill and experience.

Overall, Arozullah and colleagues’ findings highlight the fact that important risk factors are often immutable patient characteristics, such as age and clinical history (5). Thus, we are challenged to think more broadly beyond preoperative risk stratification to aggressive use of proven interventions for example, lung-expansion maneuvers or pain control), especially in high-risk patients, and creative new risk-reduction strategies for clinical trials. Studies must clarify the duration of preoperative smoking cessation that confers benefit. In the two studies to date, fewer complications occurred only in patients who had stopped smoking for at least 8 weeks before coronary artery bypass and 4 weeks before pulmonary resective surgery. In both studies, those who stopped smoking for shorter periods had more postoperative pulmonary complications than those who continued to smoke (10, 11).

To understand and use the growing literature for clinical decisions, it is important to appreciate the inherent methodologic difficulties of research in perioperative care. First, when complications are infrequent, clinical trials must be appropriately large to assess effectiveness of prophylactic interventions. Second, definitions of complications should be explicit and rigorous, and surveillance must be systematic. Third, authors must design their studies so that they are useful to clinicians; doing so requires authors to decide, for example, between studying many or few surgical procedures and complications. With these problems in mind, the giant of pulmonary operative risk management arises and looks to the horizon.

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References