Benefits of Aggressive Perioperative Management in Patients Undergoing Thoracotomy*

John J. Reilly, Jr MD, FCCP

With lung resection remaining the cornerstone of curative therapy in patients with lung cancer, aggressive perioperative management continues to play a critical role. This review summarizes the most important factors in successful perioperative management. These include patient selection, with an emphasis on which patient variables and hemodynamic assessments are most useful in determining operability. Postoperative management, in particular, patient-controlled analgesia, and pulmonary toilet, are essential to facilitate early patient mobility and to minimize complications, respectively. Aggressive perioperative management can result in reduced postoperative morbidity and mortality, reduced length of hospital stay and expenditures for complications, and it expands the population that can receive potentially curative therapy.

**Patient Selection**

Several recent reviews have examined the principles of patient evaluation prior to planned resectional surgery.1-6 A variety of factors have been examined to assess "operability" in patients; they include pulmonary function, exercise capacity, gender, age, and extent of planned resection. There is general agreement among clinicians, and substantiation in the literature, that preexisting lung disease, as manifested by abnormal pulmonary function test results, denotes a population of patients at increased risk for morbidity complications and death in the perioperative period. Unfortunately, preoperative spirometry does not accurately identify the minority of patients in this high-risk population who will develop complications.7 Attempts to further stratify these patients at risk have been made utilizing a variety of techniques, including right heart catheterization, balloon occlusion of pulmonary arteries, and exercise testing.

Several studies, including one recently published from our institution,4 document the fact that the predicted postoperative forced expiratory volume in 1 second (PPO FEV₁) is a predictor of postoperative morbidity and mortality. For patients with peripheral abnormalities visible on chest radiograph and normal to mildly obstructed spirometry, a simple

Table 1—Use of Radionuclide Scanning to Predict Postoperative Pulmonary Function*

<table>
<thead>
<tr>
<th>Author</th>
<th>No. Patients</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kristersson et al 9</td>
<td>19</td>
<td>Scanning and PFTs accurate predictors of postoperative VC (r=0.73)</td>
</tr>
<tr>
<td>DeMeester et al 10</td>
<td>20</td>
<td>Scanning and PFTs as good as bronchspirometry (r=0.95), better than lateral position test (r=0.86)</td>
</tr>
<tr>
<td>Olsen et al 11</td>
<td>13</td>
<td>Good prediction: (VC, r=0.70; FEV₁, r=0.72)</td>
</tr>
<tr>
<td>Ali et al 12</td>
<td>27</td>
<td>Good correlation</td>
</tr>
<tr>
<td>Corris et al 13</td>
<td>28</td>
<td>Good correlation with spirometry (VEmax, VO₂)</td>
</tr>
<tr>
<td>Kristersson et al 8</td>
<td>27</td>
<td>Good correlation (VC, r=0.87, FEV₁, r=0.90)</td>
</tr>
<tr>
<td>Tonnesen et al 14</td>
<td>25</td>
<td>Good correlation (r=0.89)</td>
</tr>
<tr>
<td>Schoonover et al 13</td>
<td>24</td>
<td>All patients had severe COPD. Scanning superior to lateral position test</td>
</tr>
</tbody>
</table>

*PFTs=pulmonary function tests; VC=vital capacity; VEmax= maximal ventilation per unit of time.

Reprinted from Reilly et al.6

*From the Division of Pulmonary and Critical Care Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston. Reprint requests: Dr. Reilly Jr., Brigham & Women's Hospital, 75 Francis St, Boston, MA 02115

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calculation (5.26% per resected segment) accurately predicts postoperative function. In patients with central masses, documented or suspected endobronchial obstruction, pleural disease, or severe obstructive lung disease, quantitative ventilation/perfusion scanning provides an accurate assessment of postoperative function. The studies documenting this are listed in Table 1. Conventional teaching and practice are that patients with a PPO FEV₁ of <800 mL are at high risk and are often considered to have unresectable disease. Published experience at several centers, however, has documented that resectional surgery for patients with PPO FEV₁ of <800 mL is feasible, although these patients are clearly at higher risk for development of postoperative complications and death.

The data concerning invasive hemodynamic assessment of postoperative risk are conflicting and are summarized in Table 2. Taken as a whole, these data do not support the routine use of invasive hemodynamic measurements as a preoperative assessment tool. The data concerning exercise testing, also summarized in Table 2, suggest that some form of exercise testing helps to identify a subset of high-risk patients who are able to tolerate parenchymal resection. Patients with a maximum oxygen consumption >15 mL/kg/min or who can climb three flights of stairs have acceptably low morbidity and mortality after potentially curative thoracotomy. These data support the use of exercise testing in the evaluation of patients otherwise considered at high risk by virtue of underlying obstructive lung disease or other comorbid conditions. There is limited experience in operating on high-risk patients with poor exercise performance, but the reports (summarized in Table 2) suggest high perioperative morbidity and mortality rates.

Other factors often cited as risk factors include gender, age, and hypercarbia. Some studies have suggested that men are at increased risk after thoracotomy as compared with women. A number of studies have examined age as a contraindication to thoracotomy. Taken as a group, these data suggest that age alone is not a contraindication to surgery, but it may play an additive role with other comorbid factors. Hypercarbia has often been cited as a contraindication to thoracotomy, but two recent studies demonstrate that it is possible to operate safely on patients with PCO₂ >45 mm Hg.

In summary, patients being considered for pulmonary resection should have spirometry as a standard part of their assessment. Should the history, physical examination, or testing done during initial evaluation demonstrate severe obstructive lung disease or other comorbid conditions that place the patient at high risk for postoperative complications, some form of exercise testing has been shown to be useful in further stratifying risk for adverse perioperative events. Neither age nor hypercarbia alone is a contraindication for thoracotomy.

## Preoperative Management

There are limited data concerning the utility of aggressive preoperative intervention in improving perioperative outcome. One study examined this question directly and found that smoking cessation, bronchodilators, and pulmonary toilet reduced the incidence of postoperative complications. In patients with reactive airways disease, whether asthma or chronic bronchitis, a short course of corticosteroid

### Table 2—Hemodynamic and Exercise Testing Prior to Thoracotomy

<table>
<thead>
<tr>
<th>Author</th>
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<tbody>
<tr>
<td>Fee et al¹⁹</td>
<td>45</td>
<td>PVR better predictor of postoperative complications than PFTs, ABGs</td>
</tr>
<tr>
<td>LAros and Swierenga²⁰</td>
<td>142</td>
<td>Pulmonary artery pressures not predictive of complications</td>
</tr>
<tr>
<td>Brundler et al²¹</td>
<td>637</td>
<td>Developed algorithm of FEV₁, Dco, P₂O₂ to predict patients with pulmonary hypertension. No prognostic data</td>
</tr>
<tr>
<td>Olsen et al¹¹</td>
<td>52</td>
<td>29 patients operated on. PVR not predictive. Cardiac index, O₂, and V̇O₂ more predictive of complications than lung scanning and PFTs</td>
</tr>
<tr>
<td>Miyoshi et al²²</td>
<td>33</td>
<td>V̇O₂/BSA at La-20 predictive of mortality, not complications. PFTs not predictive of mortality but predictive of complications</td>
</tr>
<tr>
<td>Bechard and Wetstein²³</td>
<td>50</td>
<td>MVo₂ &gt;20 mL/kg/min: 0% mortality, morbidity; MVo₂ &lt;10 mL/kg/min, 2/7 died, 3/7 complications. All deaths in the MVo₂ &lt;10 mL/kg/min group</td>
</tr>
<tr>
<td>Smith et al²⁴</td>
<td>22</td>
<td>MVo₂ &lt;15 mL/kg/min, 6/6 complications; MVo₂ &gt;20 mL/kg/min, 1/10 complications</td>
</tr>
<tr>
<td>Olsen et al²⁵</td>
<td>54</td>
<td>Retrospective review. Stair climbing. Increased complications in patients unable to climb &gt;3 flights</td>
</tr>
<tr>
<td>Morice Rodolfo et al¹⁸</td>
<td>37</td>
<td>Clinical stage 1 patients. High risk. MVo₂ &gt;15 mL/kg/min in 13/34; 8 had surgery, 2 complications</td>
</tr>
<tr>
<td>Miller²⁶</td>
<td>217</td>
<td>84 patients (2,340 total) who passed Reichel ETT underwent pneumonectomy; 5% mortality</td>
</tr>
<tr>
<td>Gerson et al²⁷</td>
<td>16</td>
<td>(177 total) Increased complications in patients unable to perform supine cycle ergometry</td>
</tr>
</tbody>
</table>

*PVR=pulmonary vascular resistance; PFT=pulmonary function test; ABG=arterial blood gas; Dco=diffusing capacity of lung for carbon monoxide; P₂O₂=arterial oxygen pressure; V̇O₂=oxygen consumption; BSA=body surface area; La-20=arterial lactate of 20 mg/dL; MVo₂=maximum oxygen consumption; ETT=exercise tolerance test.

Modified from Reilly et al.⁴
therapy may prove helpful.

Less clear is the utility of preoperative pulmonary rehabilitation, i.e., a course of intensive education and supervised exercise undertaken to improve cardiovascular fitness, pulmonary hygiene, medication compliance and utilization, and smoking cessation. Such a multidisciplinary approach has been documented to improve well-being and daily function and to reduce hospitalizations. Although it has not been formally studied in the preoperative setting, many believe that selected patients benefit from a short (3- to 4-week) course of such intensive therapy prior to surgery. This time interval also allows some recovery from smoke-induced airway inflammation in current cigarette smokers, which is a significant benefit in this population.

Postoperative Management

Postoperative Analgesia

There is universal agreement that deep breathing and early mobilization in the immediate postoperative period facilitates rapid recovery and minimizes respiratory and other complications (such as deep venous thrombosis/pulmonary embolism). Several approaches have been utilized to provide adequate postoperative analgesia. A number of trials have examined different postoperative analgesic regimens, using pain relief, pulmonary function, sedation, nausea, and itching as study variables. Although one study suggested that the mode of action of epidural narcotics is via systemic absorption, most studies conclude that there is less sedation and superior analgesia with regional analgesia rather than parenteral narcotics. Studies examining local intercostal analgesia compared with epidural analgesia show roughly equivalent efficacy. The studies do not show any measurable difference in pulmonary function in the immediate postoperative period with intercostal vs epidural analgesia use.

Another aspect of perioperative analgesia under active investigation is the timing of the initiation of analgesic therapy. This is based on the observation that analgesic treatment begun prior to surgical incision may result in superior pain control compared with therapy begun during the operation. At the present time, the data suggest that a postoperative regimen that uses one of the patient-controlled or local/regional analgesic techniques discussed above is preferable to the past practice of physician-scheduled analgesic medication. Adequate analgesia is essential to facilitate early patient mobility and to allow patients to take deep breaths.

Postoperative Pulmonary Toilet

In order to minimize complications, adequate pulmonary toilet is essential after thoracotomy. Pneumonia, atelectasis, and respiratory failure represent a substantial number of the morbid events after thoracotomy. Published studies have clearly demonstrated that deep breathing in the postoperative period minimizes pulmonary complications. The method used to achieve this goal is less important. Coaching by the care team, incentive spirometry, and intermittent positive-pressure breathing have been demonstrated to have equivalent efficacy in reducing pulmonary complications (the benefit of incentive spirometry being the deep breath the patient takes prior to exhaling forcibly). Many clinicians feel that selected patients benefit from bronchoscopy to remove secretions in the postoperative period. Although conservative measures such as bronchodilators and chest physical therapy have been demonstrated to be as efficacious as bronchoscopy in a general intensive care unit population in correcting atelectasis or removing secretions, no study exists that examines patients after thoracotomy. It is logical to conclude that some patients with impaired pulmonary reserve who have undergone significant pulmonary resection may benefit from postoperative “toilet bronchoscopy.” This is particularly true for patients who have undergone pneumonectomy.

Efficacy of Combined Approach

No randomized controlled studies exist to document the efficacy of careful preoperative evaluation, intensive preoperative intervention, and a multidisciplinary approach to postoperative management using local/regional analgesia and early mobilization. Recent published experience from this institution, however, documents acceptably low morbidity and mortality rates in patients treated in such a fashion. The mortality in this group of patients, 1% in the low-risk group and 2% in the high-risk group, compares favorably to earlier reports for similar surgery. Concomitant with reduced morbidity and mortality is a reduced length of hospital stay, with most patients discharged 1 week or less after thoracotomy.

REFERENCES


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